FOUNDRY TRADE JOURNAL

Established 1902

WITH WHICH IS INCORPORATED THE IRON AND STEEL TRADES JOURNAL

Vol. 66 Thursday, February 5, 1942 No. 1329

THE FOUNDRY TRADE JOURNAL

49, Wellington Street, London, W.C.2.

WARTIME ADDRESS to which all communications should be sent until further notice:—

3, Amersham Road, HIGH WYCOMBE, Bucks.

Telegraphic Address: "Zacatecas, High Wycombe."
Telephone: HIGH WYCOMBE 1792 (3 lines).

PUBLISHED WEEKLY

Subscription Terms (Home and Overseas): 21s. per annum. All Subscriptions are payable in advance.

OFFICIAL ORGAN OF

The Council of Ironfoundry Associations
The Institute of British Foundrymen
The Institute of Vitreous Enamellers
The Welsh Engineers' and Founders' Association
The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen

PRESIDENT: 1941-42

Major R. Miles, M.Eng., Head Wrightson & Company Limited, Thornaby-on-Tees.

LIST OF SECRETARIES—

General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester, 3. London Office: 49, Wellington Street, W.C.2.

BRANCHES

Birmingham, Coventry and West Midlands: A. A. Timmins, F.I.C., 21-23, St. Paul's Square, Birmingham, 3.

East Midlands: S. A. Horton, "Three," Mostyn Avenue, Littleover, Derby.

Lancashire: A. Boyes, "Roseville," 7, Kirkstall Road, Davyhulme, Manchester.

London: V. C. Faulkner, 3, Amersham Road, High Wycombe.

Middlesbrough (pro tem.): J. K. Smithson, North-Eastern Iron Refining Company, Limited, Stillington, Stockton-on-Tees.

Newcastle-upon-Tyne: C. Leahly, Sir W. G. Armstrong, Whitworth & Co. (Ironfounders), Ltd., Close Works, Gateshead.

Scottish: J. Bell, 60, St. Enoch Square, Glasgow.

Sheffield: W. Webb, B.Sc., 20, Brookfield Avenue, Swinton, Mexborough, Yorks.

Wales and Monmouth: J. J. McClelland, 12, Clifton Place, Newport.

West Riding of Yorkshire: S. W. Wise, 110, Pullan Avenue, Ecclesihill, Bradford.

South Africa: F. C. Williams, Mutual Building, Corner of Harrison and Commissioner Streets, Johannesburg.

SECTIONS

Bristol: A. Harse, 167, Ridgeway Road, Fishponds, Bristol.

Burnley: H. Buckley, Elsmere, Norfolk Avenue, Burnley, Lancs.

East Anglian: J. L. Francis, 12, Glenhurst Avenue, Colchester Road, Ipswich.

Falkirk: T. R. Goodwin, "Viewfield," Falkirk Road, Bonnybridge, Scotland.

Lincoln: E. R. Walter, M.Sc., The Technical College, Lincoln.

The Institute of Vitreous Enamellers

President: Professor J. H. Andrew, D.Sc., Department of Applied Science, The University, St. George's Square, Sheffield.

Chairman: W. H. Whittle, W. H. Whittle, Limited, Eccles, near Manchester.

Hon. Secretary: Dr. G. T. O. Martin, 21-23, St. Paul's Square, Birmingham, 3.

Foundry Trades' Equipment and Supplies Association

President: G. E. France, August's, Limited, Thorn Tree Works, Halifax.

Acting Secretary: Miss L. Cox, 52, Surbiton Hill Park, Surbiton Surrey.

Welsh Engineers' and Founders' Association

President: W. E. Clement, C.B.E., Morfa Foundry, New Dock, Llanelly.

Secretary: J. D. D. Davis, 9, Royal Metal Exchange, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION

The Registered Office and Laboratories of the B.C.I.R.A. are:—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone: Colmore 4274-4275 Telegrams: CIRA

The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk (*Phone:* 382)

Council of Ironfoundry Associations

Chairman: FitzHerbert Wright, The Butterley Company, Ripley near Derby.

Secretary: V. Delport, 2, Caxton Street, Westminster, S.W.1.

Participating Associations:

National Ironfounding Employers' Federation.
British Ironfounders' Association.
National Association of Malleable Ironfounders.
Ironfounders' National Confederation.
British Bath Manufacturers' Association.
British Malleable Tube Fittings Association.
Cast Iron Chair Association.
Greensand Pipe Founders Association of Scotland.
Cast Iron Heating, Boiler, and Radiator Manufacturers' Association.
Cast Iron Segment Association.
National Ingot Mould Association.
Cast Iron Axlebox Association.
Institute of British Foundrymen (affiliated).
British Cast Iron Research Association (affiliated).
British Grit Association (affiliated).
Agricultural Engineers' Association (affiliated).

"Knots"

Considerable interest is being shown in foundry circles in the disproportionate activities of the various branches of the Institute of British Foundrymen. From one important centre, for instance, we have received no news of any meeting being held since the war began, whilst from others, happily the majority, the high pre-war standard has been well maintained. Generally speaking, the branches are all situated in industrial areas, and therefore the conditions under which they operate are not dissimilar. Whilst the officials of any one branch could put forward an imposing list of reasons for the total suspension of activities during the war, most of them have found ways and means of overcoming these difficulties. It is a time-honoured custom, for example, for a complete lecture programme to be arranged at the beginning of each session, based on promises to lecture from eminent technologists drawn from a wide area. This has proved to be the chief stumbling block, for few men are now at liberty to make distant promises, and travelling is difficult. It is suggested, therefore, that a radical departure from this tradition should be the order of the day. The improvised programmes of some branches are achieving considerable success. One branch which has not exhibited much activity in recent months has restarted its programme with a talk by an eminent American foundry technologist who is at present in this country on business. Yet another branch, finding that the main bugbear is travelling in the black-out, has successfully solved its difficulties by holding its meetings in the summer.

The larger branches have special problems of their own. They cover an extremely wide area, and it is often difficult for all the members to reach a central meeting place at a time convenient for everybody. It is frequently found that some districts embraced within a large branch will carry quite large "knots" of foundrymen, which may either be a group of foundries situated quite close together or may be in a residential suburb where many foundrymen have their homes. In one such suburb an enthusiastic member, who is not in any way an official of the branch, proposes to arrange a local gathering of members living in his district. This would take the form of a simple dinner at a local hotel to be followed by an informal talk. The advantages of such a scheme are manifold, for apart from reducing travelling to a minimum, it is a good thing for neighbours with similar interests to get to know each other better. There are many day-to-day troubles arising directly from war conditions, and it would be comforting to know that there might be someone in the immediate neighbourhood who can help to solve these problems with the minimum of delay. The interpretation of the numerous Government orders is a case in point, many smaller firms liking to follow the lead of the larger ones. Much value would be derived from the undisputed fact that when two or three practical or scientific men are gathered together in this country, they invariably "talk shop," and "talking shop" cannot do otherwise than enlarge the technical knowledge of all concerned. Meetings of this character would also help to enlarge the local cultural and social life, which is necessarily restricted by war conditions.

It is reasonable to expect that the outcome of a series of such local meetings would enhance the work not only of the branches but of the Institute, for they would form a channel through which the basic technical requirements of the ordinary member would filter to the inner council. The attendance at the ordinary branch meetings could also be expected to increase following an awakening of technical interests.

It would be interesting to ascertain how many "knots" could be found in the suburbs of our large cities or even in the smaller satellite towns. That many such centres do exist we feel reasonably sure, and we commend the idea, which is not our own, to the consideration of any enthusiastic foundrymen. We feel certain that any unofficial effort made on these lines would receive both sympathy and support from the officials of the Institute.

Contents

	PAGE
"Knots"	81
Metal Control Complete	82
Correspondence	82
C.I.A. Technical Committee	82
Random Shots	82
Investigation of the Influence of Mould Friction on Tearing in Castings	83
Research in the Iron and Steel Industry	87
Vitreous Enamelling Section:—	
The Properties of Enamel Opacifiers	90
South African Iron and Steel Industry	94
Reorganised Training of Welders	94
The Week's News in Brief	96
Trade Talk	96
Obituary	96
Personal	96
Contracts	96
Raw Material Markets	98

Metal Control Complete

BY "ONLOOKER."

With the suspension of dealings in tin goes the last free market in non-ferrous metals and control now covers the whole field, for nickel and cadmium were roped in by Orders operating from New Year's Day. It is perhaps remarkable that trading in tin futures went on as long as it did, but events in the Far East early in December made it obvious that rationing of available metal would be necessary if supplies were to be conserved and employed in a manner best calculated to serve the war effort. The metal trade generally has now become well accustomed to control of supplies and price stability, which in the case of copper, lead and spelter has existed since the outbreak of the war. The original prices fixed for these three metals in September, 1939, being found to be too low, an upward revision was made in December of that year, since when there has been no change in values. In the early days of the war certain difficulties arose and from time to time objections were raised by the trade, but, on the whole, matters have proceeded smoothly, due largely to the regular exchange of views between officials of the Ministry of Supply and the representatives of the manufacturers. Moreover, the supply position has improved and consumers have been able to obtain, if not just the brands to which they were accustomed, then something reasonably akin.

The section of the business community which has suffered most is that comprising the dealers whose activities were confined mostly to operations on the Metal Exchange. Merchant houses, too, have lost ground so far as virgin metals are concerned, for the Non-ferrous Control section of the Ministry of Supply is itself a gigantic merchant house, handling the distribution of metals and attending to the constant flow to this country from overseas. There is, too, the question of stocks held at various points in the United Kingdom, an aspect of the supply situation which might well assume great importance in the event of invasion. While no official statement has been made upon the scope and variety of Lend-Lease aid from the United States, it is generally supposed that non-ferrous metals in one form or another have figured in this supply, and it is a little difficult to see how, under a system of private trading, a transaction of this type could have been handled. In any case, most people would agree that the Ministry of Supply is the right body to shoulder the responsibilities of such a deal, and now that America is in the war, careful planning for the distribution of what is available, coupled with the pooling of reserves, is more than ever important.

In scrap the position is rather different, for merchants and dealers continue to function fairly freely within the limitations of the Control Order, which makes it necessary for consumers to obtain licences and places a ceiling upon the values of different grades of secondary metals. True, the recent instructions relating to the disposal of scrap by manufacturers cuts across merchant interests, but there remains a good deal of material for them to handle, and in connection with this the expert sorters in the employment of many metal merchants are of the greatest possible help, for theirs is a skilled job based on years of experience. The price situation in scrap is somewhat obscure, for in addition to the lists of what may be called merchant prices published week by week, the Control now makes a separate announcement, comprising details of the values of specific types of process scrap which should be adopted when manufacturer and customer fail to agree on a price. It is too early yet to tell how this will work out, but it should be noted that these prices are *fixed*, whereas hitherto Control quotations have consisted of fixed *maximum* limits.

Correspondence

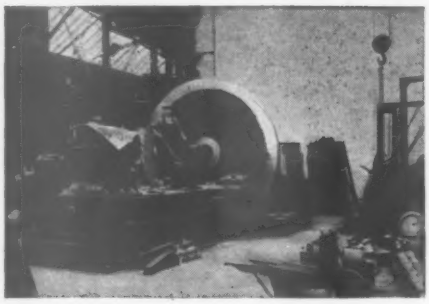
[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Cast-Steel Winding-Drum Cheeks

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—In view of a letter dealing with green-sand castings, published in your issue of January 15, we are sending forward to you a photograph showing large cast-steel winding-drum cheeks, of which we turned out dozens, the smallest casting weighing about 30 cwts. and the largest close on 3 tons.

The photograph shows two half-cheeks assembled, but you will observe from the size



of the man that these green-sand castings, which were very successful, are of very considerable size.

We understand that, in America, steel castings up to 8 tons are made in green sand. We ourselves have made steel castings as heavy as 5½ tons in green sand with complete success.—Yours, etc.,

FOR THE NORTH BRITISH
STEEL FOUNDRY, LIMITED,
(G. M. MENZIES, Managing Director).

Bathgate.
January 22, 1942.

Clean Bronze Statuettes

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—During a period when a section of the Thames was at an unusually low level, I found an excellent example of an Indian bronze casting of the goddess Siva (?). It is in quite good condition, but I would like to make it really clean. What method should I employ?—Yours, etc.,

GIRL GUIDE.

C.I.A. Technical Committee

The Council of Ironfoundry Associations has appointed its own Technical Committee to consider such technical problems of interest to the industry, particularly in connection with war production, that may be submitted to them by members of the C.I.A. The membership of the Technical Committee of the C.I.A. comprises Dr. Harold Hartley, Dr. J. E. Hurst and Mr. J. G. Pearce, nominated by the B.C.I.R.A., and Mr. J. Gardom, Mr. A. E. Peace and Mr. P. A. Russell, nominated by the I.B.F. The committee held its first meeting in Birmingham on January 13, when Dr. H. Hartley was elected chairman. The secretary of the Committee is Mr. V. Delport.

Address Wanted

The Editor requests Dr. B. Deutsch to communicate his present address to him to repair a gap in his records.

Tap Salvage by Brazing

An interesting example of how a tap die was back in service four hours after it had broken into ten pieces is given in a recent issue of "The Iron Age." The various pieces were cleaned and brazed with a medium silver hard solder flowing freely at 1,175 deg. F.

Random Shots

Planning for Peace!—A suggestion has been thrown out that vitreous enamelling firms should already be manufacturing street signs with which to flood the Continental market after the war. It will be imperative that every French town has its *Place* Churchill and *Boulevard* Roosevelt. In fact, one member of the industrial brains trust who knows the German mentality well, goes so far as to suggest that signs for Germany should be prepared immediately. At the first available opportunity, he suggests, British labour should be rushed across to Berlin to construct two new roads. One would cut Berlin in two from north to south, and the other from east to west, heedless of any existing street planning. In this way the German people would have a permanent eradicable Churchillstrasse to greet them at every street ending. Attempted evasion by going down back streets would only result in being compelled to walk along an endless Rooseveltstrasse. This would be the surest damper on the irrepressible spirits of a new generation of post-war Germans born with short memories and an infinite capacity for wishful thinking.

* * *

Discussing the recent story of the toughness of the American marine, a Northern steel-foundry manager immediately claimed at least more foot-pounds of that illusive property for his family. "Why," he said, "when my Dad used to visit my aunts, aged 92 and 95, they would run down the garden path and jump over the gate. They would ferret around his parcels and, finding the usual 4-lb. pork pie and links of polony, would wolf them like a pair of school kids."

"Aye," retorted his bright young colleague from Braintree; "I've heard tell of them. They joined the A.T.S. last week."

* * *

In fact, the consumption of beer and the ability to eat large pork pies seemed the definite Edwardian forerunner of the Izod and Charpy test for toughness. Do many ex-metallurgical students of Sheffield University remember "Chinny"? He was either a gas maker or a second hand, but his chief claim to notoriety was the complete absence of a chin. Students would buy beer for "Chinny" for the distorted pleasure of seeing him pour it down his orifice which possessed no "gurgle," and hear it splash somewhere in the region of his tummy. A great test of manliness amongst the workmen in Sheffield in those care-free days was to walk down the Attercliffe Road from the Wicker Arches to Tinsley (if possible), having a drink at every "pub" on the way. The hero was, of course, he who could outdistance and out-"pub" the others, and in these races "Chinny" usually came in an easy first. He was also alleged to be the champion pork-pie eater.

* * *

A little idea for economy in the use of paper can be taken from a former era when good writing paper was also scarce; scarce because it was a hand-made luxury and because of conditions arising out of the Napoleonic wars. In reading old correspondence one becomes quite accustomed to certain abbreviations, such as "shd," "cd," and "wd"; though, if one thought about it at all, to save paper would be the last explanation given for thus contracting certain familiar words. Old letters, too, were nearly always written in very small script and exceedingly closely.

* * *

The most erudite clue of the week comes from the "Sunday Times."

Clue: Houyhnhnm Romeo?
Answer: Horse lover.

"MARKSMAN."

Investigation of the Influence of Mould Friction on Tearing in Castings*

By Prof. J. H. ANDREW, D.Sc., and H. T. PROTHEROE, B.Sc.
(University of Sheffield)

The disastrous effect of the hot tearing of steel castings of complicated design is well known, and is generally attributed, amongst other things, to the resistance offered by the sand to the contraction of the casting, with the result that such methods as digging away sand from the region of runners and feeder heads, construction of collapsible cores, etc., are resorted to. Such methods constitute so far the only means by which this tearing is minimised and very often prevented altogether. It is not hard to see that in some castings even these simple preventatives, although applied, cannot be expected to be fully effective, and the steel founder has then to rely on the skill of the welder to make his castings acceptable.

During contraction, particularly solid contraction, the casting must obviously move, if only ever so slightly. In the case of complicated box-like castings this contractional movement is uniform in neither rate nor direction. The former depends on the uniformity of temperature, and the latter on the design of the casting, the location of cores, etc. The actual position of the resulting "tear" is that portion of the casting which, at the moment when these contractional stresses and sand resistances cannot be resisted further, is the weakest—namely, the *hottest* position. Coupled with this resistance, offered to the contracting casting by the body of the sand itself, is the possibility that there is actual friction between the sand grains and the surface of the casting. If this mould friction is great then the normal movement of the casting is further restricted and the liability of tearing is augmented.

Investigation

The following series of experiments were devised to uphold or disprove the contention that mould friction is a contributory cause to the tearing of steel castings. To eliminate such factors as non-uniformity in the direction of contraction, the pattern selected for these experiments was a simple bar 4 ft. long, 1½ in. wide and ½ in. thick. These dimensions were finally decided upon after a few preliminary experiments with a bar 4 ft. long, 2 in. wide and ½ in. thick had failed to give anything but sound castings.

The first series of experiments was conducted using a two-part moulding box of the following internal dimensions: Top part, 4 ft. 6 in. long, 7½ in. wide, 3 in. deep; bottom part, 4 ft. 6 in. long, 7½ in. wide, 3¾ in. deep. The actual casting was located in the bottom box, so that with the above dimensions it was ensured that the casting was completely surrounded by a uniform body of sand, that is, 3 in. (All experiments conducted in this box are indicated by the prefix S_3.) The resistance to contraction as a result of the body of the sand was thus, in all cases, uniform, and any variation in this resistance when using different sands, it was thought, would be due entirely to variations in the degree of mould friction.

Three bars in each of three different sands were made, using this moulding box. The mechanical analyses of the sands were conducted in a Crook elutriator used in conjunction with a Boswell elutriator. The former, after sieving to 1 mm., separated the sand, silt and clay, the sand portion being graded further in the Boswell elutriator. Table I gives the grading of each sand in accordance with Boswell's classification.

It will be noticed that the sand can be designated fine, medium and coarse. In each case the silt portion was very small, so that it was decided not to separate into coarse silt and fine silt. In all the experiments the sand received the same treatment, that is, adding the bentonite, milling dry for 5 mins., adding the moisture and then milling for a further 10 mins. The moisture was kept at approximately 4.5 per cent. in each instance. The amount of bentonite added was 5 per cent., and all the bars were cast in green sand. As previously stated, the whole of the casting was located in the bottom box, the runner and riser being contained in the top half. Fig. 1 is a photograph of the casting obtained.

Immediately before pouring, the casting temperature was obtained by means of a tungsten-molybdenum immersion couple. Each casting was allowed to remain in the box for the same length of time before being knocked out, and was then examined in the following manner: The extent of tearing was first noted, Figs. 2 and 3 being chosen as representative of typical tears. In the case of the latter the two portions of the casting were barely joined when the box was stripped, and this is typical of the most severe tearing obtained. Fig. 2 is typical of the type of tear obtained in the majority of the castings. In three instances only, which are referred to in Table III, was the tearing less severe than that shown in Fig. 2.

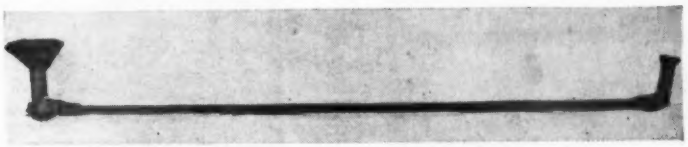


FIG. 1.—A CASTING AS STRIPPED FROM THE MOULDING BOX, SHOWING TEAR AT RUNNER END.

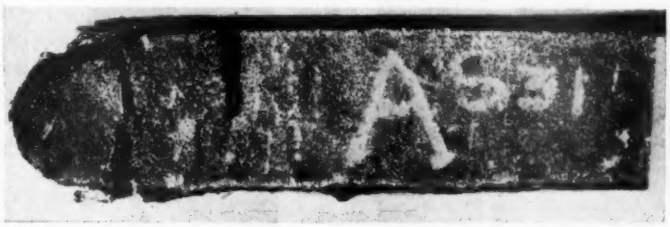


FIG. 2.—TYPE OF TEAR OBTAINED IN THE MAJORITY OF CASES.

FIG. 3.—THE MOST SEVERE TYPE OF TEARING.

TABLE I.—*Grading of Each Sand in Accordance with Boswell's Classification.*

Sand.	Very coarse sand (> 1 mm.). per cent.	Coarse sand (0.5–1.0 mm.). per cent.	Medium sand (0.25–0.5 mm.). per cent.	Fine sand (0.1–0.25 mm.). per cent.	Silt (0.01–0.1 mm.). per cent.	Clay (< 0.01 mm.). per cent.	Total sand per cent.
A	—	—	18.4	77.0	2.6	1.8	95.4
B	4.2	21.6	70.8	2.0	1.3	0.9	98.6
C	26.4	54.3	9.5	7.7	0.3	2.0	97.9

The casting was then cut into eight portions, as indicated in Fig. 11, the surface of each portion being suitably prepared in order to obtain sulphur prints. It was afterwards reground and repolished and given a neutral etch with copper-ammonium-chloride, it being hoped that the grain size would indicate any variation in the rate of cooling throughout the length of the bar. Unfortunately, the etching did not show this, therefore, after the first half-dozen or so bars were examined in this way this treatment was discontinued. The sulphur prints were substantially the same in each instance, and only two samples, picked at random, are shown in Figs. 4 and 5. It will be noticed that there is a decided sulphur segregation near the runner and riser ends of the casting. As is pointed out later, however, it is not thought that this phenomenon is a contributory factor to the tearing of the bars.

Micro-sections were taken from each bar from the regions indicated in Fig. 11, and as these in all instances showed no useful result, only two are shown in Figs. 6 and 7. Table II summarises the results of series S_3.

A minor point of practical importance was

* Paper No. 2/1941 of the Steel Castings Research Committee, of the Iron and Steel Institute.

Influence of Mould Friction

noticed in regard to bar $S_3$1. Being one of the bars of which a macrograph was obtained, it was noticed that over the whole length of the bar small nests of blow-holes were situated at regular intervals, corresponding to the position of the cross bars in the top box. This was the result of using the vent wire too far away from each cross bar. In subsequent casts the vent wire was driven down the side of each cross bar directly over the pattern, and no further blow-holes occurred.

A second series of experiments was conducted, using the same three sands as before but with moulding boxes of the following dimensions: Top part, 4 ft. 8 in. long, 9½ in. wide, 4 in. deep; bottom part, 4 ft. 8 in. long, 9½ in. wide, 4⅛ in. deep. (All experiments conducted in this box are indicated by the prefix S_4.) The results are summarised in Table III.

Casts $S_4$1, $S_4$4 and $S_4$5 are the three casts referred to above which did not crack so severely as the majority of the castings. No satisfactory explanation can be given. By using these larger S_4 boxes the body of sand is increased by 1 in. all round, and it was thought that the increased resistance to contraction offered by a larger body of sand would be shown by a more severe type of tearing. Actually this was not so, and with the exception of $S_4$4 and $S_4$5, the nature of the tearing was the same as in the S_3 series.

It was suspected by this time that tearing occurred regardless of the nature of the sand. Castings produced in the coarse-grained sand did not tear more severely than those produced in the fine-grained sand. Mould friction therefore, if at all contributory to this tearing, was only so tc a very small degree.

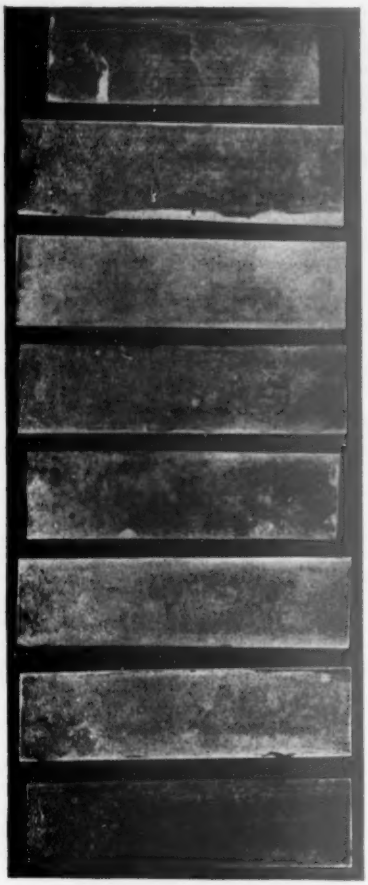


FIG. 4.

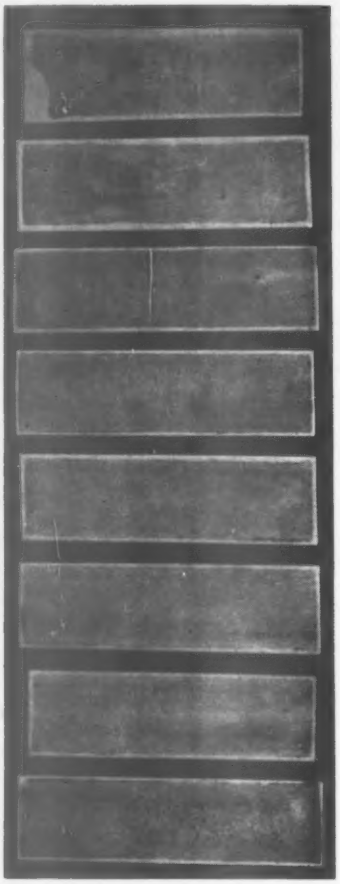


FIG. 5.

FIGS. 4 AND 5.—TYPICAL SULPHUR PRINTS.

TABLE II.—*Series* S_3.

Sand.	Bar No.	Analysis.*			Casting temperature deg. C.	Remarks.
		C per cent.	Si per cent.	Mn per cent.		
A	$S_3$1	0.40	0.20	1.22	1,510	Cracked, as Fig. 2.
	$S_3$2	0.31	0.3	0.7	1,530	
	$S_3$3	0.29	0.31	0.73	1,540	
B	$S_3$4	0.30	0.30	0.70	1,520	
	$S_3$5	0.31	0.29	0.68	1,550	Cracked, similar to $S_3$1.
	$S_3$6	0.32	0.31	0.71	1,520	
C	$S_3$7	0.29	0.30	0.68	1,535	
	$S_3$8	0.33	0.31	0.71	1,515	
	$S_3$9	0.32	0.29	0.71	1,546	

* Sulphur and phosphorus in all casts between 0.03 and 0.035 per cent.

It was assumed that body or bulk resistance of the sand was the chief factor. Consequently the volume of sand surrounding the casting was further increased and a series of experiments commenced using boxes of the following dimensions:—Top part: 4 ft. 10 in. long, 11¼ in. wide, 5 in. deep; bottom part: 4 ft. 10 in. long, 11½ in. wide, 5⅛ in. deep. This added volume of sand definitely had an effect. The tearing was more severe than in the S_3 or S_4 series. In a few instances the final bar was only just joined together. Fig. 3 is a photograph of bar $S_3$1, which so severely cracked that it parted when being lifted from the box. The results are shown in Table IV.

FIG. 6.

FIG. 7.

FIGS. 6 AND 7.—TYPICAL AS-CAST MICROSTRUCTURES.

It was realised at this stage that it would be of great assistance if more definite information could be obtained regarding the precise moment at which tearing occurred, and the temperature of the casting at this moment. After one or two unsuccessful runs a method was devised whereby the temperature of the bar could be recorded almost from the time of casting. A tungsten-molybdenum couple was constructed and inserted in the mould as indicated in Fig. 12. The couple was protected by an outer alundum sheath, and the wires were insulated from each other by encasing one wire in a fine-bore silica sheath. A hole was cut in the moulding box, through which the couple was inserted into the outer sheath which had been placed in position during ramming. This outer sheath was insulated from the sand by wrapping in mica sheet.

It was found essential to insert the end of the thermocouple in the stream of metal entering the mould. This served to raise the alundum sheath to the temperature of the metal before the mould was completely filled. The time lag was thus reduced to a minimum. In previous

Influence of Mould Friction

attempts the thermocouple was inserted in the centre of the bar, through the bottom, and it was found that the time lag was too great. Actually the thermocouple did not commence recording until the bar had cooled to about 900 deg. C.

between the bar and the leads which completed the circuit.

It was assumed that the severe tearing of the casting would have an effect on the conductivity of the bar, which would be shown by an increase in resistance. This method, however, is not sensitive enough, and the slightest connection between the two portions of the bar is sufficient to carry the current from a

TABLE III.—*Series* S_4.

Sand.	Bar No.	Analysis. C per cent.	Si per cent.	Mn per cent.	Casting temperature deg. C.	Remarks.
A	$S_4$1	0.23	0.17	0.8	1,540	Cracked, but not quite so severely as $S_3$1.
	$S_4$2	0.34	0.20	0.74	1,530	Cracked similarly to $S_3$1.
	$S_4$3	0.30	0.22	0.63	1,525	
B	$S_4$4	0.23	0.17	0.8	1,530	Cracked, less than $S_4$1.
	$S_4$5	0.34	0.20	0.74	1,530	Only slightly cracked.
	$S_4$6	—	—	—	1,545	Not a successful cast. There was a run-out near the runner, and mould did not fill. Even so, the bar cracked slightly.
C	$S_4$7	0.32	0.31	0 6	1,550	Cracked similarly to Fig. 3.
	$S_4$8	0.30	0.28	0.71	1,528	Cracked similarly to $S_3$1.
	$S_4$9	0.28	0.31	0 8	1,510	

FIG. 8.—CASTING WITH SLOPING RUNNER AND RISER.

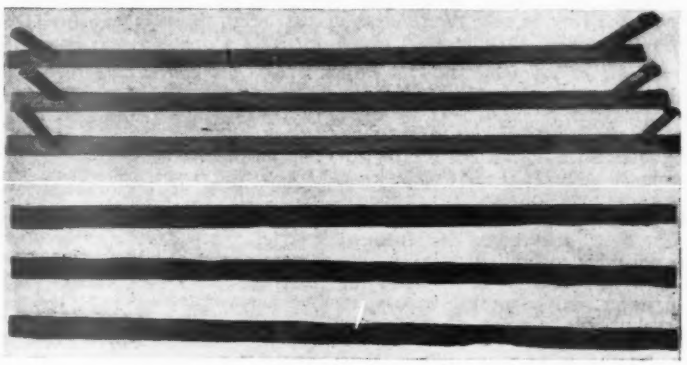


FIG. 10.—SOME CASTINGS MADE WITH SLOPING RUNNERS AND RISERS.

TABLE IV.—*Series* S_5.

Sand.	Bar No.	Analysis. C per cent.	Si per cent.	Mn per cent	Casting temperature deg. C.	Remarks.
A	$S_5$1	0.31	0.29	0.7	1,548	Cracked severely.
	$S_5$2	0.30	0.30	0.67	1,520	Cracked not quite so severely as $S_5$1.
	$S_5$3	0.33	0.29	0.80	1,524	
B	$S_5$4	0.34	0.31	0.7	1,550	Cracked similarly to $S_5$1.
	$S_5$5	0.36	0.33	0.66	1,530	
	$S_5$6	0.28	0.31	0.70	1,525	Cracked similarly to $S_5$2.
C	$S_5$7	0.38	0.29	0.72	1,510	Cracked similarly to $S_5$1.
	$S_5$8	0.30	0.32	0.69	1,538	
	$S_5$9	0.32	0.30	0.74	1,518	

A few attempts have been made to determine at what temperature the bar cracked by using this thermocouple in conjunction with a resistance circuit. The bar was incorporated in the circuit as indicated in Fig. 13. After the pattern had been withdrawn from the mould, two mild steel rods, which had been previously cleaned, were inserted so as to project about ½ in. into the actual mould. Suitable notches were cut in the edges of the bottom box in order to take the rods. These were insulated by means of mica sheet, and served as connections 2-volt accumulator. Increasing the current did not prove any more satisfactory, and the project was abandoned.

Box	S_3	S_4
Sand	*B*	*A*
Casting temperature, deg. C. ..	1,520	1,525

At this stage it had been definitely concluded that it was the bulk resistance of the sand to the contraction of the casting which caused the tearing. Further, every bar without exception cracked at the runner end. By the sluggishness of the metal rising through the riser it was realised that there was a marked temperature gradient from riser to runner. It follows that the direction of contraction is parallel to the length of the bar from riser to runner, as indicated in Fig. 14. The contraction along the width of the bar is relatively much smaller and can be ignored. The obvious remedy to alleviate tearing was realised a very long time ago, and is still in use at the present time. That is, the digging away of the sand from the region of the runner and riser. A method not quite so obvious is to slope the runner and riser. Fig. 8 is a photograph of a casting produced with sloping runner and riser. It was made in the S_3 box using sand C, and is perfectly sound. When sloping in this manner both the runner and riser slide with the casting during contraction, and the contraction stresses are sufficiently relieved to prevent tearing.

To permit of each runner and riser to fit in the box it was necessary to knock out a bar from each end of the moulding box. It was realised that the absence of these bars from close proximity to runner and riser might in itself be sufficient to ease the strain due to the resistance of the sand, and consequently another casting was made by the ordinary method using the same box minus these two bars. Fig. 9 is a photograph of the tear which resulted. A further series of bars using sloping runners was made with different boxes, varying the sand each time. All the bars obtained were sound and no indication of tearing was observed. The

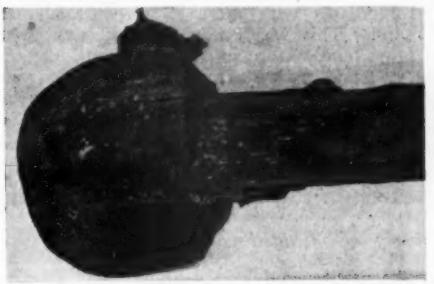


FIG. 9.—TEAR OBTAINED WITH ORDINARY METHOD OF CASTING, BUT WITH NO CROSS-BARS IN THE TOP BOX IN CLOSE PROXIMITY TO THE RUNNER OR RISER.

number of bars made is indicated below, and Fig. 10 shows photographs of some of these bars.

These experiments with sloping runners were continued in a slightly modified manner. The angle of slope was varied from 30 deg. to 80 deg. and the bars were cast in the boxes used for series S_4. Six bars were cast in all with the runners sloping at 30 deg., 40 deg., 50 deg., 60 deg., 70 deg. and 80 deg. Each bar was sound. It appears therefore that in castings of such small dimension the slightest slip is enough to ease the resistance to contraction sufficiently to prevent tearing.

Conclusion

From the large number of tests carried out it would appear that hot tearing is due rather to the resistance offered to contraction by the bulk of sand than to the nature of the sand itself. When steel castings are stripped from the box, it is observed that there is a thin layer of burnt sand between the face of the casting and the

Box	S_4	S_5	S_5	S_5	
Sand	*C*	*A*	*B*	*C*	
Casting temperature, deg. C. ..	1,525	1,514	1,540	1,533	

main body of the sand. This layer is very friable and, provided the refractoriness was originally sufficient, it is easily removable from the casting. However, after being submitted to

Influence of Mould Friction

a temperature as high as that of molten steel, there is no strength in this sand. It is not likely, therefore, that there is any resistance offered to the contractional movement of the casting. It is quite possible, on the other hand, that the friction between *molten* metal and the sand increases with increase in coarseness of the sand. This was observed when casting at the same temperature in different sands. In the case of sand *C*, metal cast at the same temperature appeared to take longer to fill the riser than when cast in sand *A*. The head of metal in each case was the same, but the rate of pouring was not controlled, which might account for it.

No attempt is made to explain the sulphur segregation near the runner and riser, but it is felt that the temperature at the crucial moment during contraction will decide where the casting tears. In every test carried out this was near the runner, that is, in the hottest region. Given uniformity of temperature, the bar is quite as likely to crack near the riser as near the runner. The degree of purity might possibly influence the location of the tear in this case.

With regard to casting temperature, the only deduction possible from the varied number of casting temperatures employed is that tearing occurs some time after solidification, probably very soon afterwards. It is known that at such temperatures steel is very weak, and it is also known that metals contract at a quicker rate at elevated temperatures than at lower temperatures. These facts when taken together indicate that tearing occurs somewhere in the neighbourhood of the solidification temperature. It has been shown that, provided one runner is set at a sloping angle, hot tearing will not occur.

FIG. 11.—MANNER OF SECTIONING CASTINGS TO OBTAIN SULPHUR PRINTS AND MICROGRAPHS.

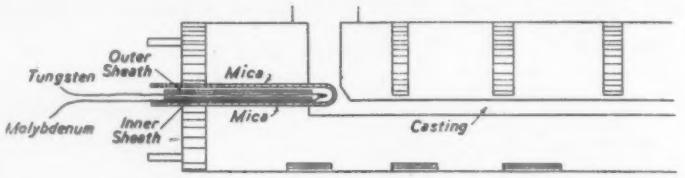


FIG. 12.—METHOD OF INSERTING THE THERMOCOUPLE IN THE MOULD.

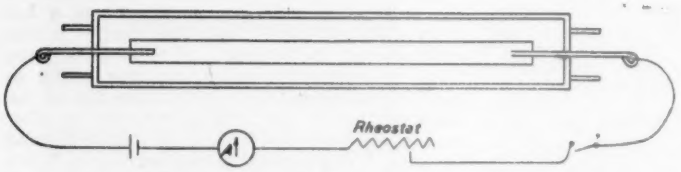


FIG. 13.—METHOD OF INCORPORATING THE CASTING IN AN ELECTRICAL CIRCUIT IN AN ATTEMPT TO DETERMINE THE TEMPERATURE AT WHICH THE CASTINGS CRACKED.

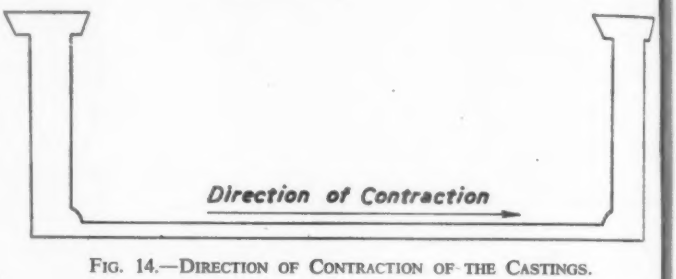


FIG. 14.—DIRECTION OF CONTRACTION OF THE CASTINGS.

Research in the Iron and Steel Industry

(*Concluded from page* 88.)

have been discussed briefly above. As already indicated, the first and most important accomplishment is the improvement in quality with no significant increase—indeed, in some cases with a decrease—in cost. This has been especially evident in the past decade and has affected all branches of the industry. Pig-iron is more uniform in composition and quality than ever before; precision melting in the basic open-hearth process, with instrument control, with slags of carefully adjusted composition and with regulated deoxidation to produce steels of specific grain size, is now common. New methods for exact control of the Bessemer process and for improved slag practice are being used, and good quality free-machining steel with 0.30 to 0.40 per cent. of sulphur is made regularly.

Improving the quality of steel without a significant increase in cost to the consumer is an accomplishment of considerable magnitude as the stricter metallurgical control necessary raises the basic cost of the material. According to White (1937), unalloyed steel containing 0.25 per cent. of carbon, made without modern metallurgical control and testing, cost $43.04 a ton in 1936. The same steel made with complete metallurgical control and testing costs as much as $60.48 a ton, a possible increase of $17.44, of which $3.23 represents the cost of the metallurgical control and testing, and the remainder, $14.21, represents the increased cost of the various manufacturing operations owing to more rigid quality requirements.

The continuous rolling mill has been responsible for a reduction in the price of 20-gauge sheet steel for automobile fenders from 6 cents per lb. in 1923 to 3½ cents in 1936; it has improved the quality with the result that the deformation possible in drawing a fender crown has increased from 2½ in. in 1923 to 16 to 18 in. in 1936. To-day, only the nose of the fender is polished, and the paint consists of one coat of primer and one coat of finish; in 1923, three polishing operations and four priming and finishing coats were necessary. Research in corrosion and in protective coatings, and the development of alloy steels, have more than doubled the average life expectancy of all iron and steel in the last 50 years. In 1890 the average life was 15 years, in 1910 it was 22 years, and in 1935 it was 35 years. A considerable part of this increase is due to higher and more uniform quality, with fewer early failures.

The development of low-alloy steels, which cost between 3½ and 5 cents per lb. as compared with 2½ cents per lb. for unalloyed structural material, has had—and is now having—a great effect on the design and construction of railway rolling stock. A hopper car constructed of low-alloy steel weighs 30,000 lbs. and carries 139,000 lbs. as compared with a weight of 44,000 lbs. and carrying capacity of 125,000 lbs. for the conventional car. This is equivalent to converting 7 tons of dead weight into revenue-producing capacity. Savings accompanying the use of higher temperatures and pressures in power generation and in oil refining are even more spectacular, and are due almost solely to the development—much of it in the United States—of alloy steels which resist deformation at high temperatures.

These are only a few of the advances in the iron and steel industry of the United States in the past 15 or 20 years which have resulted from research. The list could be extended almost indefinitely; enough has been said, however, to show that research in the iron and steel industry—which has certainly only begun—has had a strong stimulative effect on general industrial progress in the United States.

REFERENCES

[1] William Kelly in the United States probably anticipated Bessemer's invention by nearly 10 years, but was never able to make the process work satisfactorily. The credit for the invention is, therefore, usually given to Bessemer, although it is claimed by some that without the help of Mushet he would have made no more headway than Kelly.
[2] Private communication to American Iron and Steel Institute.
[3] Steel Research Budget for 1938. *Steel Facts*, No. 27, vol. (August, 1938).
[4] Davis, R. M. "Research a Paying Investment." New York National Research Council, Division of Engineering and Industrial Research, 1928.
[5] Private communication, American Iron and Steel Institute.
[6] There is some disagreement among authorities on the actual number of research workers, ascribable to the fact that there is disagreement on how some workers shall be classified.
[7] Stoughton, Bradley. "The Training of a Metallurgist." *Yearbook of the American Iron and Steel Institute*, 1939, pp. 79-89.
[8] Speller, F. N. "Co-operative Research in the Iron and Steel Industry." *Yearbook of the American Iron and Steel Institute*, 1931, p. 48.
[9] Gillett, H. W. "U.S.S. Carilloy Steels." *Metals and Alloys* 10, M.A. 186 (March, 1939).

New Caledonia Nickel

Production of nickel ore in New Caledonia was 229,000 metric tons in 1940, against 250,000 and 275,000 tons in 1939 and 1938 respectively. There has been a steady increase in production since 1934 (171,000 tons), principally owing to the modernisation of the plants by the Société Le Nickel. Nickel matte and ferro-nickel exports were 7,886 metric tons in 1940, against 9,302 tons in 1939 and 8,031 tons in 1938, the bulk going to France. Exports of nickel ore in 1940 were 60,000 tons (all to Japan), 49,400 tons in 1939 (40,000 tons to Japan), and 23,300 tons in 1938 (12,600 tons to Japan and 11,000 tons to Germany). With the fall of France in June, 1940, exports of matte and ferro-nickel to that country ceased. To assist the colony, the Australian Government, in co-operation with the International Nickel Company of Canada, took over the entire production. Exports to Australia were actually for reshipment to the United States. At the beginning of 1941, exports of nickel ore to Japan were restricted to 24,000 tons annually.

Asowstal No. 4 Furnace

According to a full description of the furnace by W. MISCHTSCHENKO, in "Stal," No. 4 furnace at the Asowstal works has an internal volume of 1,300 cub. m., and produces 1,500 to 1,800 tons of pig-iron in 24 hrs.

Research in the Iron and Steel Industry

ANALYSED AS A NATIONAL INDUSTRIAL RESOURCE OVER THE LAST CENTURY

By FRANK T. SISCO,
Metallurgist and Editor, Alloys and Iron Research, N.Y.

(*Concluded from page* 69.)

Organisation of Research in the American Steel Industry

Owing to the wide variation in size of the individual units of the American iron and steel industry, and to the diversity of processes and products, there naturally can be no standard of organisation. In small plants, a technical staff of 2 to 20 men can handle all the routine metallurgical, chemical and mechanical testing—and occasionally supervise inspection as well—and can plan and carry out a considerable amount of valuable research work in improving processes and materials.

The large company with a central research laboratory employs 50 to 75 men in this laboratory, and frequently 20 to 50 additional men in various plants—or departments if there are only 1 or 2 plants. The large, well-balanced research laboratory—of which there are a number in the United States—employs metallurgists, physicists, chemists, mechanical and ceramic engineers, and a number of other technically-trained men, one-quarter or one-third of whom hold doctorates. For example, one has a staff of technically-trained men, skilled in methods of measuring and controlling high temperature; in methods for the elucidation of the constitution and behaviour of refractories and slags; in thermodynamic analysis of the chemical reactions involved in the making of iron and steel; in the methods of identification and control of the structure of steels and conversant with the relations between structure and the useful properties of steels.

Large steel-plant research laboratories act as training schools, transferring metallurgists and other technically-trained men from the various plants or subsidiary companies to the central laboratory for a year or two of what amounts to intensive graduate training, thus giving these men a broad view of research, as it is undertaken for the good of the company as a whole.

One of the most important things encountered in organising and operating a large research laboratory is the choice of problems. Most directors of research adopt the general principle that the solution of the problem should be applicable to the company as a whole, leaving to the metallurgists of the various plants or subsidiary companies the problems of more restricted application encountered in their particular plant, with the proviso, of course, that the staff of the central laboratory should always be available for consultation, if necessary, even on minor difficulties.

The staff of the central laboratory of a company that makes steel also frequently co-operates on problems with the research staff of the company that fabricates the steel and of the company that uses the fabricated article. An excellent example of such co-operation is in the manufacture of pressure vessels for use at high temperatures, where satisfactory service depends quite as much upon the method of fabrication and welding of the vessel as upon the melting practice used to make the steel.

Cost of Research

It is difficult to determine accurately the amount of money spent for research by the iron and steel industry of the United States. For the past five years or more it has averaged almost $10,000,000 annually, according to a survey recently made by the American Iron and Steel Institute, which shows the following, as spent by 42 companies representing about 90 per cent. of the steelmaking capacity of the country.

Year.	Expenditure.
1929	$8,700,000
1935	$8,100,000
1936	$9,200,000
1937	$10,300,000
1938	$9,500,000

It is interesting to note that the expenditure for research in 1938 was only 8 per cent. lower than in 1937, despite a decrease of 60 per cent. in steel production. The money spent for research is distributed approximately as follows:

Project.	Per cent.
Improving quality	33
Improving methods of manufacture and reducing cost	19
Developing new products..	20
Developing new uses and markets ..	28

The annual appropriation by individual companies is naturally not available for publication. A survey made 13 years ago[4] indicated that for 12 large steel plants the average annual research expenditure was $16,200. This is undoubtedly less than one-tenth of the average expenditure to-day. Actual research appropriations for 1939 by one large- and two medium-sized steel companies[5] were as follow:—Company A, $1,250,000, of which $950,000 was for salaries; company B, $285,000; company C, $278,000. These amounts are approximately ten times the amounts spent by these same companies ten or fifteen years ago.

Research Personnel

The iron and steel industry employs as many as 1,000 college graduates annually, over 70 per cent. of whom have engineering degrees. Of 583 recent graduates employed, 149 were mechanical engineers, 97 were chemists and chemical engineers, 95 were civil engineers, 70 were metallurgical engineers, 57 were mining engineers, 42 were electrical engineers, and 83 had other degrees. Of these graduates, 21 per cent. went into the metallurgical department, 35 per cent. went into open-hearth, rolling-mill or power-generation work, 29 per cent. were employed in other operating departments, and 15 per cent. went into sales and administrative work.

Most of the large steel companies have organised plans for selecting college graduates and maintain close contact with the principal engineering schools. A number of the companies provide summer employment for likely undergraduates. There has been no lack of employment for graduate metallurgists from the country's outstanding engineering schools during the past 10 years; even in 1932-33 most graduates were placed quickly.

In general, there are fewer doctorates in metallurgy than in other branches of science; in three years (1934-37) 28 doctorates were awarded to metallurgists, compared with 1,449 in chemistry and 178 in agriculture. During this period the same number of doctor's degrees were awarded in metallurgy as in oriental literature. The relatively small number of doctorates in metallurgy awarded at American universities is, however, no criterion of the number of scientists with doctor's degrees employed by the iron and steel industry, as many of these were trained as physicists and physical chemists. In 1937, according to a survey made by the American Iron and Steel Institute,[6] 2,350 engineers, metallurgists, chemists, physicists and other technical men were employed full time in the research laboratories of the steel companies. In addition, almost 1,200 other employees devoted some part of their time to research work.

Metallurgical Education

College curricula in metallurgy have not been standardised in the United States. According to Stoughton, dean of engineering at Lehigh University,[7] who studied the metallurgical courses in 22 accredited schools, all curricula included some courses in metallurgy and mathematics, chemistry, physics and English, and most included drawing. Only nine included a foreign language, which was a serious handicap, as at least one-third of the reports of metallurgical research published in recent years have appeared in German periodicals. In most engineering schools, students of ferrous metallurgy spend 75 to 100 hrs. in a steel plant; frequently, they have a good idea of the operation of a blast furnace before they even calculate a heat balance.

In 1936-37, there were 1,630 students in metallurgy in 53 colleges in the United States, out of a total of 7,190 students registered in all branches of minerals technology, or nearly 23 per cent. Of these, 131 were graduate students who made up 30 per cent. of those working for an advanced degree. Owing to a shortage of experienced metallurgists in that country, registration has increased considerably in the past 6 or 8 years; in the 53 schools surveyed by Plank, 937 were registered in metallurgy in 1933-34 and 1,630 in 1936-37.

There has been considerable discussion in recent years on whether or not metallurgical education in the United States sets as high a standard as it is reasonably possible to attain in a 4-year course. According to Stoughton, "the characteristics most conducive to success and of most service to industry which a student can gain in college and which he did not have before are judgment and self-confidence based on a knowledge of fundamentals." In this, American metallurgical education apparently has not been wholly successful, as is evident from a reading of some of the publications of the Society for the Promotion of Engineering Education. The chief difficulty seems to be that the world has changed so fast that metallurgical curricula have not kept pace. It is generally recognised now that in addition to fundamentals of metallurgy stressed by Stoughton, the graduate metallurgist needs a basic training in social and economic science if he is to cope adequately with any problems in the steel industry except fundamental research. How he is to attain such training in a 4-year course is at present an unsolved problem.

Co-operative Metallurgical Research in Germany and Great Britain

The amount of co-operative research participated in or sponsored by the American iron and steel industry has increased in the last 20 years, but it is still considerably less than that so aided in Germany and Great Britain. The organisation of co-operative research in Germany and England is frequently held up as exemplary of a far-sighted programme and should be outlined briefly.

According to Speller[8], co-operative research in Germany is divided into fundamental research, and the practical application of this in industry. Fundamental research is carried out by some 35 institutes, supported jointly by industry and the Government; for research in ferrous metallurgy, the Kaiser-Wilhelm Institut für Eisenforschung is known all over the world. This institute, founded in Düsseldorf in 1918, is financed by the iron and steel industry through its organisation, the Verein deutscher Eisenhüttenleute—

Iron and Steel Research

only the salary of the director is paid by the Government—and the work is supervised by technical committees of the Verein, who also assign to the research laboratories of the various steel companies problems which are not suitable for the Institute, and who supervise the practical application in the mills of fundamentals worked out at the Institute.

Two systems of co-operative research are used in England. One, a joint project sponsored by the Iron and Steel Institute and the British Iron and Steel Federation, is devoted to research of value to the industry as a whole. Joint committees select the problems and arrange for the work to be done by qualified scientists. The Iron and Steel Institute contributes a small amount of money and affords a medium for publication; most of the financial support comes from the Federation. Splendid work has been done on this joint project over the past 15 years; the best known reports are the series on the heterogeneity of steel ingots, already mentioned, and on corrosion.

The other principal British instrumentality for co-operative research is the Department of Scientific and Industrial Research started in 1916. This is financed by the industries concerned and by the Government, each contributing about half. Publication is possible only by permission of both industry and Government. Only a small number of the problems investigated are metallurgical.

Co-operative Metallurgical Research in the United States

In the United States, most co-operative metallurgical research was, until about 1925, carried out by the various technical societies, either alone or in co-operation with industry or with the National Bureau of Standards or the United States Bureau of Mines. The most important and best-known work undertaken in this way was that on the corrosion of sheet steel in the atmosphere by the American Society for Testing Materials and that on the effect of temperature on the properties of metals, by a joint committee of the American Society of Mechanical Engineers. Another such valuable co-operative project is the study of soil corrosion of pipe, which has been under way for 10 years at the National Bureau of Standards with the co-operation of the pipe manufacturers. The iron and steel industry co-operated in these projects by supplying materials and the services of technical men and, in some cases, by contributions of money. There is one large endowed organisation, Battelle Memorial Institute, which is equipped to undertake a variety of research problems for trade associations or individual companies—who supply most of the funds, while the Institute supplies the facilities and the supervision—and its endowment permits it to undertake considerable unsponsored metallurgical research.

There are three relatively large co-operative research projects in ferrous metallurgy in this country which have received much favourable comment throughout the world. The first of these, established in 1926 and completed in 1934, was organised to supervise research in steel manufacture; this was conducted by the Metallurgical Advisory Board. Most of the funds were supplied by the steel industry; research facilities and scientific and other personnel were supplied by the United States Bureau of Mines and by the Carnegie Institute of Technology of Pittsburgh. Work done under this project on the physical chemistry of steelmaking has been recognised as one of the most valuable fundamental researches in steelmaking ever attempted.

The other two projects, Alloys of Iron Research and Welding Research, were organised by the Engineering Foundation and sponsored by the American Institute of Mining and Metallurgical Engineers, and by the American Welding Society and the American Institute of Electrical Engineers, respectively. These two projects are financed largely by industry, by research institutes, Government bureaus, and by relatively large appropriations from the Engineering Foundation's income from endowment.

Alloys of Iron Research is a project for reviewing the important research work of the world on carbon and alloy steels and plain and alloy cast irons, as reported in the technical literature of all countries, and for summarising and correlating the data in a series of 15 monographs of which 11 have been published. The cost of this project, which was started in 1930, is about $25,000 a year. Several hundred metallurgists have contributed enough of their time to review and criticise before publication chapters of the monographs dealing with subjects in which they are especially expert. The primary object of the monographs is to eliminate long and costly researches of the literature by research workers, to obviate duplication of research work which has been reported in obscure or inaccessible journals, and to encourage research to fill the gaps in our knowledge of ferrous materials.

Welding research, also under the direction of a technical committee, is reviewing the literature on welding of ferrous and non-ferrous materials, but, unlike Alloys of Iron Research, it is publishing its literature survey as frequent brief digests of a specific field. It sponsors and supervises laboratory research in welding which is being carried out in a number of universities and plants. Its budget is approximately $20,000 per year.

Contribution of Manufacturers of Alloying Metals to Research

The several companies in the United States—and in other countries as well—which produce nickel, chromium, molybdenum, tungsten, silicon, copper, titanium, and other alloying elements, either as the relatively pure metals or as ferro-alloys, and sell these materials to the iron and steel industry for the manufacture of alloy steels and cast irons, have been large contributors to the advancement of knowledge in the iron and steel industry. All these manufacturers maintain well-equipped research laboratories staffed by competent men, and carry out a large volume of important research work. Research by the manufacturers of alloying metals is directed primarily toward finding new uses for their metals; in other words, toward selling more of their product. All of them, however, have a liberal policy of publication of the results of their research in the technical journals, thus inviting discussion not only by metallurgists of steel manufacturers, but also of competitors.

Most of the manufacturers of alloying metals publish monthly magazines which afford prompt and wide dissemination of data of value to metallurgists in the iron and steel industry. Most important, however, are the handbooks published by the manufacturers of alloying metals and by some of the steel companies. These books are unique in advertising, because they are important sources of valuable data obtained by research. The role of these publications in the American iron and steel industry is stated accurately by Gillett.[9]

The ultimate purpose of handbooks of this type is to sell steel and specifically the steels made by, or using the elements sold by, the firm that prepares the book. Possibly there comes in also the aspect of self-protection against complaints that would be avoided by more understanding of fundamentals and, hence, more intelligent use by the purchaser. At any rate, the dissemination of sound technical information is considered so important that such handbooks have ceased to be mere catalogues and reiterations of the virtues of "Three Star Double Extra" brand, and contain, not only data, but discussions of metallurgical principles that are often far from being kindergarten subjects. These discussions must be brief, clear and correct, for the prestige of the firm is involved. Few textbooks are written with the care for correct phraseology that one meets in these books. Consequently, the student as well as the practising metallurgist values them highly—and they deserve to be highly valued.

Research for New Markets for Alloying Metals

As noted above, approximately 50 per cent. of the money appropriated for research by the iron and steel industry of the United States is spent for developing new products and new uses and markets for old products; during the past 20 years, practically all the money appropriated for research by the manufacturers of alloying metals has been spent for this purpose.

Almost immediately after it was discovered that nickel and chromium increase the strength, hardness and resistance to impact of carbon steels, steel containing these two metals was used for armour plate and ordnance, and caused a revolution in offensive and defensive naval warfare in the first decade of this century. The expanding armament programmes of all nations which culminated in the first World War demanded such large quantities of these alloying metals, especially nickel, that the primary object of practically all research before 1920 was to increase production and to reduce cost.

Nickel production increased from 10,000 short tons in 1900 to 50,000 short tons in 1917, about half of which went into armaments. With the end of the war came the collapse and world production of nickel dropped to about 10,000 tons, the 1900 level. It became painfully apparent about 1920 that no permanent benefit would be derived, either by the manufacturers of the alloying metals or by the steel industry as a whole, from metals whose most important application was in armaments. As a result, extensive research was begun to find new and peacetime uses for these metals. That this research has been successful is apparent from a study of the statistics of production of alloy steels in the United States during the period (1920-35) when practically no armaments were made. In 1920, alloy-steel production was 1.5 million tons, in 1937 it was 3.2 million tons, which went into automobiles, railway rolling stock, shipbuilding, oil-refining equipment, power-generating machinery, tools, agricultural equipment, architectural, trim and building construction, electric-heating appliances and many other products.

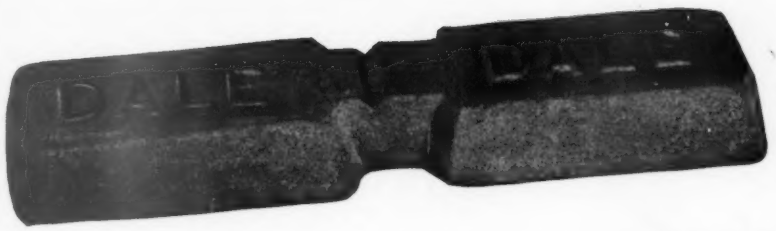
Between 1920 and 1937, the International Nickel Company alone spent approximately $18,750,000 in development and research to create peacetime uses for nickel. During that time, the yearly production of nickel increased from 10,000 to 125,000 short tons, of which only 3 to 5 per cent. was used in steel for armaments between 1920 and 1935. Even in 1937, when Europe had begun to rearm on a large scale, less than 8 per cent. of the world's supply of nickel was used in armaments. Research by the International Nickel Company and by manufacturers of other alloying metals has developed peacetime uses for their products to the point that complete world disarmament would not cause a ripple in their yearly production; it would, in fact, even be welcomed because, as Stanley pointed out in 1938, "organisation for war has had a depressive rather than a stimulating effect on total nickel consumption, since the loss which results from the dislocation of normal industrial routine is in no sense compensated for by the tonnage consumed in armaments."

Economic Significance of Research in the American Steel Industry

The principal advances, especially in processes and materials, that have resulted from research in the American iron and steel industry

(*Continued on page* 86.)

STANTON-DALE



Refined

PIG IRON

IS CHARACTERISED by closeness of grain structure, uniformity of composition and fine graphitic carbon evenly distributed.

IS PRODUCED to guaranteed analysis in seven standard grades.

CAN BE MADE to customers' individual requirements with total carbon from 2·6 per cent. upwards.

SHOULD BE USED to tone up high phosphorus irons and scrap, to replace Hematite, and to produce castings for all high duty purposes.

Users are invited to avail themselves of the Stanton Technical Service which offers free expert advice on special mixtures and other Foundry problems.

THE STANTON IRONWORKS COMPANY LIMITED, NEAR NOTTINGHAM

The Properties of Enamel Opacifiers*

By G. T. O. MARTIN, Ph.D, A.I.C.

(*The British Cast Iron Research Association*)

Introduction

By an opacifier is meant a substance or mixture or combination of substances, which may or may not be pure chemical compounds, added to a vitreous enamel at a suitable stage of its preparation or application, and producing the effect known as opacity. The word "opacity" is defined in the Oxford English Dictionary as the quality of being impervious to light. The ability of a layer of material to transmit light is independent of its light-reflecting properties, and according to the above definition any layer of material, black, white or coloured, can be opaque if it does not transmit light.

Applied to vitreous enamels, opacity means ability to reflect light, since the base is usually of metal, which itself would prevent light transmission. Light can be reflected from a surface in two ways, directly (or specularly) and diffusely. Direct reflection resembles that given by a mirror or polished metal surface and produces the effect known as lustre or gloss. Diffuse reflection is the reflection in all possible directions of light incident in one direction, and produces the impression of whiteness or brightness. The greater the proportion of light reflected diffusely, the whiter the appearance and the greater the opacity of the reflecting layer. It is thus convenient to express opacity as percentage of light diffusely reflected, and this figure is known as the reflectance of the layer of material. In the paint industry the term hiding power or covering power is in use. This corresponds to opacity or reflectance, although it is often measured by determining the extent to which light is transmitted through a layer of paint. The greater the amount of incident light reflected by the opaque layer, the less is the light reflected by the base material and the less the light-reflecting properties of the latter influence the appearance of the enamel layer.

It has sometimes been suggested that the opacity of an enamel layer can be determined by applying it to a glass plate and measuring the amount of light transmitted. This does not offer any advantage, since the apparatus for exact measurement would not be simpler than that for reflectance measurement, and it assumes that all the light reaching the base material is absorbed, which is not necessarily the case.

Theory of Opacity

An opaque enamel coat consists of a layer of clear transparent glass in which is present a very large number of extremely small particles having a refractive index different from that of the glass. Three effects combine to produce a turning back of the light in all possible directions:—

(1) The light may be reflected at the surface of the particles.

(2) Light entering a particle changes its direction due to the difference in refractive index, and on leaving the particle changes its direction again. This is the effect known as refraction.

(3) Light passing close to the surface of a particle will undergo a change of direction due to diffraction. The greater the difference in refractive index between the enamel glass and the opacifying particles, the greater all these effects will be. The particles can be of a material having a refractive index greater than that of the enamel glass, *e.g.*, tin oxide, cerium oxide, or less than that of the enamel glass, *e.g.*, fluorides, gas bubbles.

In addition to this requirement, the particles producing the opacity must be stable at the enamel fusing temperature, relatively insoluble in the enamel glass after cooling, and, in most cases, free from colour. The number of simple substances fulfilling these conditions is limited, although many different combinations are possible. The materials added to enamels to produce opacity do not necessarily themselves form the opacifying particles. Examination by X-ray methods has indicated that tin oxide is present as such, but zirconium oxide is not present as such but probably as small globules of a zirconium-rich glass. Antimony compounds such as antimony trioxide and sodium antimonate were said to form antimony pentoxide, but it has since been suggested that a complex alkaline earth fluo-oxy-antimonate is produced and that this complex compound is the source of the opacity. Fluorine compounds, such as cryolite, fluorspar and sodium silicofluoride, react to form sodium and calcium fluorides or fluoride complexes which are precipitated from the molten enamel on cooling. Gas opacifiers are usually organic materials which give rise to a large number of extremely small gas bubbles when the enamel is fused on the metal.

Commercial Opacifiers

It has been found convenient to divide substances used in practice as enamel opacifiers into eight main groups, as follows:—Tin oxide, antimony compounds, fluorides, zirconium compounds, titanium compounds, gas opacifiers, cerium compounds, and other opacifiers. Apart from this classification, opacifiers fall into two groups, those added to the raw batch and those added at the mill. Some opacifiers, *e.g.*, zirconium compounds, may belong to both groups.

In the course of a programme of experimental work on enamel opacifiers, attention was first given to those substances whose particular physical and chemical properties might have a pronounced effect on their effectiveness as enamel opacifiers, especially when added at the mill. It was felt that results of practical value could thus quickly be obtained and a foundation laid for other work on the same subject.

The materials of significance in this connection are tin oxide, zirconium compounds, titanium compounds, and cerium compounds (which are not used in Britain). Of these, tin oxide and zirconium compounds are in the most general use. Tin oxide is of particular interest because of the number of grades marketed by the various producers, all chemically pure, but differing greatly in apparent density, and all in demand by different users, frequently for similar purposes. Properties likely to be important in the use of these materials as opacifiers are particle size and colour.

Colour

As it is not definitely known what relation there is between the colour of the opacifier itself and the colour it imparts to the finished enamel, it will be necessary to carry out colour measurements accordingly. It has not so far been possible to complete such work, but the following results for opacifiers alone (in bulk) are of interest in showing that few of them are pure white in colour (magnesium oxide being taken as the standard of whiteness). The measurements were made with the Lovibond Tintometer, and are given in Lovibond units.

	Red.	Yellow.	Blue.
Tin oxide G	0.0	0.3	0.0
" " J	0.0	0.1	0.1
" " E	0.0	0.2	0.0
" " A	0.2	0.3	0.0
" " D	0.0	0.1	0.0
Zirconium opacifier O ..	0.0	0.2	0.0
" " P ..	0.3	0.5	0.0
" " Q ..	0.0	0.4	0.0
Titanium oxide	0.0	0.0	0.0

Particle Size

The particle size of a mill addition opacifier is likely to be important in three ways. Firstly, it will determine how well the opacifier is distributed throughout the slip or the powdered enamel. Coarser particles means fewer particles for a given addition, and hence less homogenous distribution. From this point of view fine particles would be preferable.

Secondly, it will determine how readily the opacifying particles are dissolved by the enamel glass during the fusing process. Finer particles are likely to be more readily dissolved due to the greater total surface exposed to the glass. This consideration, therefore, favours not too fine a particle size in cases where the opacifier is presumed not to dissolve in the enamel glass, *e.g.*, tin oxide, titanium oxide. With zirconium oxide, which is considered to dissolve in the enamel glass but not to diffuse uniformly throughout it, or perhaps to form a complex compound which is relatively insoluble, fine particles would be expected to be favoured.

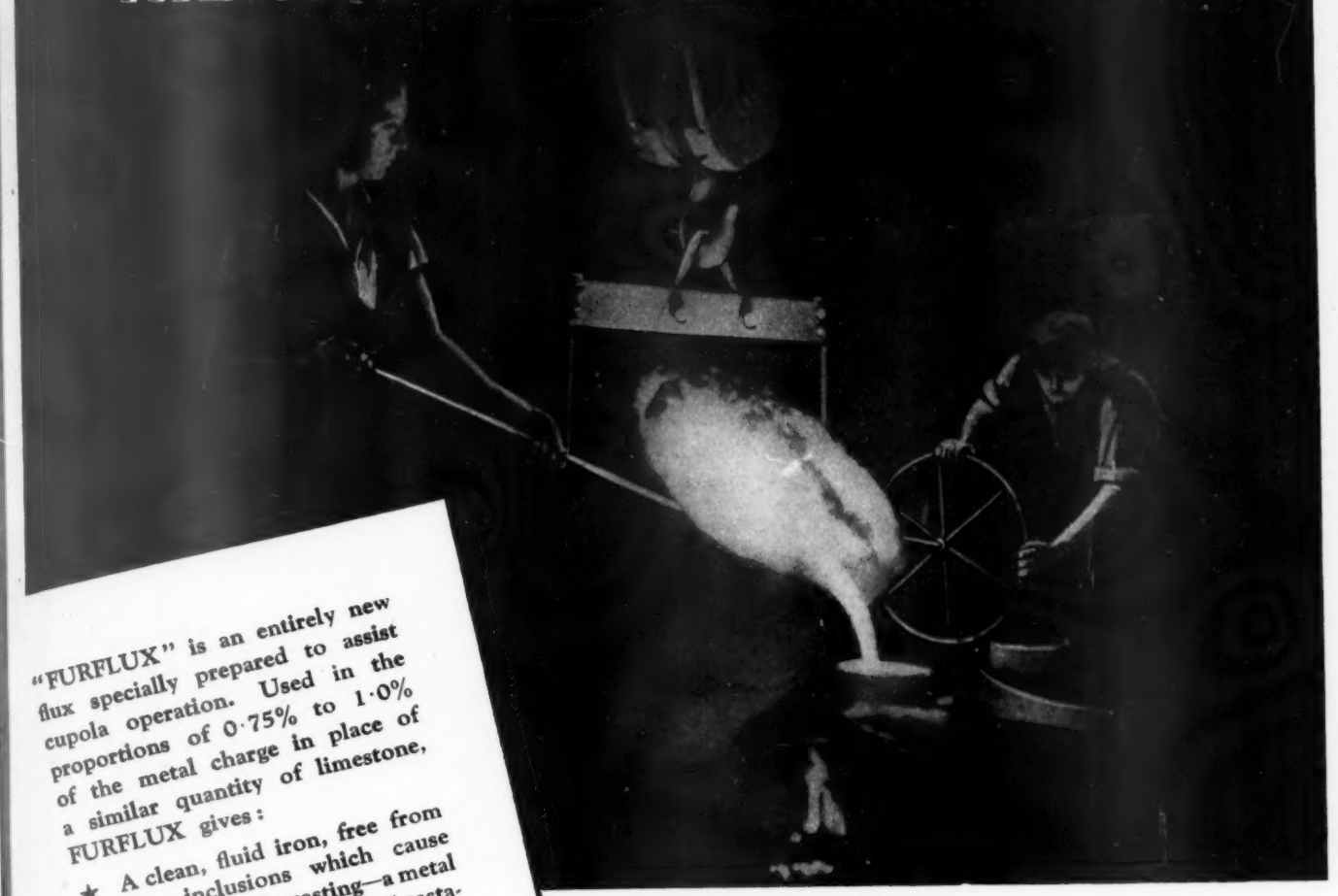
Thirdly, the size of the opacifier particles will affect the flow properties of the enamel slip. The opacifier addition is generally of the same order as the clay addition, and a proportion of the particles in most commercial opacifiers are of the same dimension as clay particles. They are susceptible to the action of electrolytes, and may be dispersed or precipitated according to the composition of the mill liquor. The relative importance of the flow properties of cover-coat enamel slip depends on the method used for its application to the ware. For flat work, using a thick enamel slip applied by spraying, the flow properties are less critical than for hollow ware using dipping and slushing methods and a much thinner enamel slip. It has been found that when tin oxide is used as opacifier in hollow-ware enamel the grade of oxide is important in that it affects the working properties of the enamel slip.

In addition to these three primary considerations, the particle size of the opacifier can influence other properties of the enamel. The

* Paper read at the Eighth Annual Conference of The Institute of Vitreous Enamellers held at Birmingham, November 1, 1941.

"FURFLUX"—

THE NEW FLUX —— for improved cupola operation concentrated by calcination



"FURFLUX" is an entirely new flux specially prepared to assist cupola operation. Used in the proportions of 0·75% to 1·0% of the metal charge in place of a similar quantity of limestone, FURFLUX gives:

★ A clean, fluid iron, free from slag inclusions which cause sluggishness in casting—a metal full of "life" and "castability."

★ Trouble-free slagging—the exothermic reactions in the formation of the slag are reflected in hotter metal.

★ A definite limitation of the degree of sulphur pick-up.

★ Refinement of the grain structure gives improved values in physical tests.

★ No detrimental action on refractories.

Manufactured by:—

Blythe

COLOUR WORKS LTD.

CRESSWELL · STOKE-ON-TRENT

REGISTERED TRADE MARK

Enamel Opacifiers

effect that fine grinding has in increasing opacity is explained by the fact that the opacifier particles do not penetrate the frit grains when the enamel layer is fused, but only fill the spaces between them, forming a coating round each frit particle. A coarse grained opacifier, introducing fewer opacifying particles into the enamel, would limit the increase of opacity produced by fine grinding of the enamel, while a fine state of subdivision of the opacifier would ensure a greater increase of opacity when the enamel is ground more finely.

The effect of opacifiers on the resistance of enamels to chemical attack has given rise to some controversy. It is sometimes stated that opacifiers decrease chemical resistance, while others claim that opacifiers increase chemical resistance. The reason for this difference probably lies in the method of measurement of the degree of attack. If this is made by prolonged treatment of the enamel with acid, the attack proceeding well into the body of the enamel it is probably true to say that opacifiers increase chemical resistance since the composition of the enamel glass may have been changed by partial solution of the opacifier, the degree of solution depending on particle size. If, on the other hand, only the surface is subjected to attack, enamel containing opacifier will appear more affected, with regard to loss of gloss, and dirt-absorbing capacity, due to its greater inhomogenity than the enamel without opacifier, where the chemical attack is more uniform. The same considerations might apply to some extent to abrasive attack.

Particle Size Distribution of Commercial Opacifiers.—In view of the number of factors likely to be affected by the particle size of mill addition opacifiers, and the demand for different grades by different users reported by manufacturers, particularly of tin oxide, a study of the particle size distribution of a number of commercial opacifiers in actual use was undertaken.

Method of Measurement

The apparatus used for the purpose was the Andreasen pipette as shown in Fig. 1. It consists of a glass cylinder 6 cm. in diameter and 30 cm. high, fitted with a ground glass stopper through which passes the tube of the pipette itself. This consists of a glass capillary tube dipping into the liquid in the cylinder. Above the ground stopper it passes *via* a two-way glass tap to the bulb of the pipette, which holds 10 ml. On the side of the cylinder twenty 1-cm. divisions are marked, the end of the capillary tube being level with the bottom mark. By means of the tap the pipette bulb can be put in communication with the capillary tube for withdrawal of a sample, or with the side tube for delivery into a weighed receptacle (in the present cast a 25-ml. glass beaker).

The method of using the pipette is as follows: A 1 per cent. suspension of the substance under investigation is placed in the glass cylinder up to the 20-cm. mark, well mixed by inverting several times, and the pipette placed in position. Ten-ml. samples are then withdrawn at various intervals of time and evaporated to dryness in weighed 25-ml. beakers. The evaporation is done on an electric hot-plate and the drying completed in an electric oven, cooling being in a desiccator. The empty beakers are dried and cooled in the same way. The time intervals used were generally 5 min., 20 min., 1 hr., 2 hr., 4 hr., 8 hr., 24 hr., 72 hr. Times close to these or even between them could be used instead if noted exactly, but were less convenient when calculating and plotting the results.

The particular apparatus used had a volume of 620 ml. up to the 20-cm. mark, so to prepare the 1 per cent. suspension 6.2 grm. of substance were shaken for one hour in a 250-ml. bottle with 100 ml. of solution. This suspension was transferred to the glass cylinder and the volume made up to the 20-cm. mark. For effective dispersion of the powders into their constituent particles a slightly alkaline solution is required, and for the compounds under investigation a very weak solution of sodium silicate (0.025 per cent.) was found to be the most efficient. A blank test was made on each lot of solution used, to obtain the exact correction to be deducted from the weights of solid material in the 10-ml. samples of suspension.

The principle of working of the apparatus depends on Stokes' Law, which gives the relation between the radius of spherical or approximately spherical particles and their rate of fall through a fluid as follows: $r = \sqrt{\frac{9h\eta}{2(D_1 - D_2)gt}}$, where r = radius of particle. h = distance of fall, η = viscosity of fluid, D_1 = density of particle, D_2 = density of fluid, g = gravitational constant and t = time. The suspension in the glass vessel of the Andreasen pipette contains particles of sizes ranging, say, from 0.01 mm. to 0.0001 mm. (10 to 0.1μ) dia. As settling proceeds, the larger particles fall more rapidly, and at any given interval of time a sample taken will include only particles finer than those which fall through a distance of 20 cm. in that time, since those coarser than this and starting from any height will have passed below the tip of the pipette. Since the suspension originally contained 0.01 grm. of solid per ml., the weight in milligrams of solid in a 10-ml. sample taken at any time (after correction for weight of electrolyte) gives the percentage finer than the size corresponding to that time of settling. By plotting size against percentage finer than size, the percentage by weight between any two size limits can be determined from the graph.

FIG. 1.—ANDREASEN PIPETTE.

In using the apparatus two other precautions must be observed. In the first place, every time a 10-ml. sample is removed the level of the liquid drops approximately 0.4 cm. All the particles therefore undergo a downward displacement of 0.4 cm. in the course of the 15 to 20 secs. required to take the sample. Those at the top will therefore have a shorter distance to fall before passing the bottom of the pipette tube. Each sample taken involves a reduction in the value of h of 0.4 cm. when calculating the size corresponding to the next sampling time. Secondly, the viscosity of water varies considerably with temperature, and it is necessary to prevent temperature changes during the course of the experiment. The ideal way of doing this is by means of a thermostat, but as this was not available, the Andreasen pipette was placed in a cupboard which had been found to keep at a steady temperature over a period of 24 hrs. During the total period of 72 hrs. some variation of temperature was unavoidable, but changes were always gradual, and the few degrees difference did not greatly affect the calculated value of the radius.

For ease of calculation, the formula for the particle radius was simplified to formulæ of the type $r = K\sqrt{\frac{h}{t}}$ where K is a constant. Thus, for tin oxide ($D_1 = 6.7$) at a temperature of 15 deg. C. ($\eta = 0.0114$) r in microns $\mu = 3.910\sqrt{\frac{h}{t}}$ where t is in minutes and h in cm. Although Stokes' Law does not hold accurately for particles of the dimensions being investigated, and ceases to be valid at all for particles below 0.5μ diameter, the method used is very useful for comparison of the different materials even if absolute measurements are not possible. It should form a convenient means of investigating the particle size of materials which it is proposed to use as opacifiers.

Materials Investigated

The opacifiers investigated are intended primarily as mill-addition opacifiers, and their physical form is therefore of greater importance than that of opacifiers added when melting the enamel, most of which are dissolved at melting temperature and re-precipitated in another form. Substances used as mill-addition opacifiers must generally remain undissolved, or only partly dissolved, and certainly do not become uniformly dispersed throughout the fired enamel layer.

With this in mind, tin oxide, titanium oxide and zirconium oxide opacifiers were used. The tin oxide and titanium oxide were chemically pure, while the zirconium oxides contained sodium oxide (6 to 9 per cent.) and silica (5 to 7 per cent.). All were commercial products, as actually used in the enamelling industry. Altogether 14 types of tin oxide, from six sources, were examined, while three zirconium oxides were obtained from one source. The titanium oxide was of the kind widely used in practice.

A number of opacifiers, of British and foreign origin, sold under various trade names, were examined and found to consist of combinations of materials such as calcium oxide, alumina, silica, phosphate, tin oxide and antimony oxide. As these would behave in various ways according to their constituents, it was felt to be useless to examine them further at the present stage.

(To be continued.)

Acid-Resisting Enamel

According to A. M. TRACHTENBERG, in "Chemitscheskoje Maschinastrojenije," an acid-resisting enamel composed of 56 to 67 per cent. SiO_2, 15 to 22 per cent. Na_2O, 0 to 8 per cent. K_2O, 0 to 6 per cent. CaO, 0 to 8 per cent. TiO_2, 2 to 4 per cent. Al_2O_3, 0 to 3 per cent. CaF_2, 0 to 3 per cent. MgO, 0 to 4 per cent. B_2O_3, 0 to 4 per cent. ZrO, and 0 to 4 per cent. ZnO, absolutely resists the mineral acids, many organic acids and mixtures of organic and mineral acids. Its coefficient of expansion is comparable to that of rolled steel.

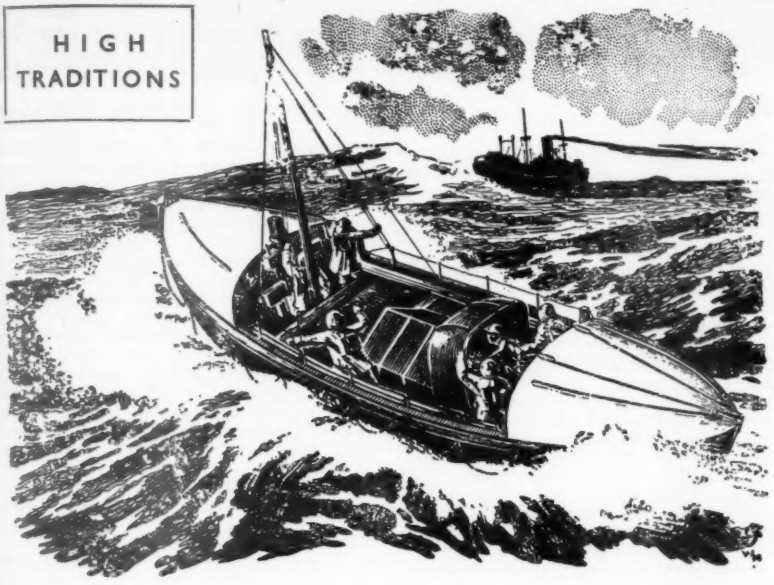
Vanadium in Cast Iron

According to co-operative tests on the value of vanadium in cast iron carried out by the Vereindeutscher Eisenhüttenleute, it appears that, contrary to statements in the literature, vanadium in cast iron does not improve tensile strength or bending strength. It cannot replace molybdenum because it gives lower modulus values. Vanadium stabilises carbide in cast iron, thereby improving volume stability at medium high temperatures, but above about 750 deg. C. this advantage is more than offset by the unfavourable effect on scale formation. Vanadium increases wear resistance with respect to sliding friction, hence is useful in engine cylinders.

Steel Plates for Aircraft Landing Grounds

The United States War Department is experimenting with portable steel plates for temporary airfields. The landing mats consist of steel plates 5 ft. long, 15 in. wide and ¼ in. thick. They are locked together to form a steel carpet big enough for a plane to land on, or take off from, rough, rocky, muddy or swampy ground, or ground deep in snow. While the steel carpet is not as smooth as concrete or asphalt, tests have shown that it permits landings and take-offs. The strip can be taken apart and loaded into trucks or railroad cars. Commenting on this development, the "American Metal Market" says that should there develop a demand for steel plates for these portable mats, the already-extremely tight plate situation in the United States, caused by the heavy requirements for ships, railway cars, tanks, boilers and certain types of pipe, would be aggravated.

HIGH TRADITIONS



SERVICE . . .

Wild gales and driving seas do not deter the valiant men of Great Britain's lifeboat organisation. More strenuous in wartime, their task of saving lives goes on, pursuing the tradition of Service which is indelibly associated with the "Red Cross of the Sea".

Behind the range of "Sirocco" Products there lies a similar tradition of Service, which finds practical expression in the efficiency of each manufacture. In particular the widespread popularity of "Sirocco" Centrifugal Fans for all classes of Heating and Ventilating work is largely due to their exceptionally high performance, both as regards volume and pressure. "Sirocco" Fans are designed to meet the varying requirements of industry—in fact, there is a "Sirocco" Fan for every purpose demanding movement of air or gases.

INSTALL TRADE SIROCCO MARK PRODUCTS

DAVIDSON & CO. LTD.

Sirocco Engineering Works,

BELFAST, NORTHERN IRELAND

Depots: **LONDON · MANCHESTER · BIRMINGHAM LEEDS · GLASGOW · NEWCASTLE · CARDIFF · DUBLIN**

On the right is illustrated a "Sirocco" Centrifugal Fan. Catalogue Ref. No. SF307 has just been published, and gives full information regarding these Fans. Write for a copy to-day.

STOP THAT WASTE

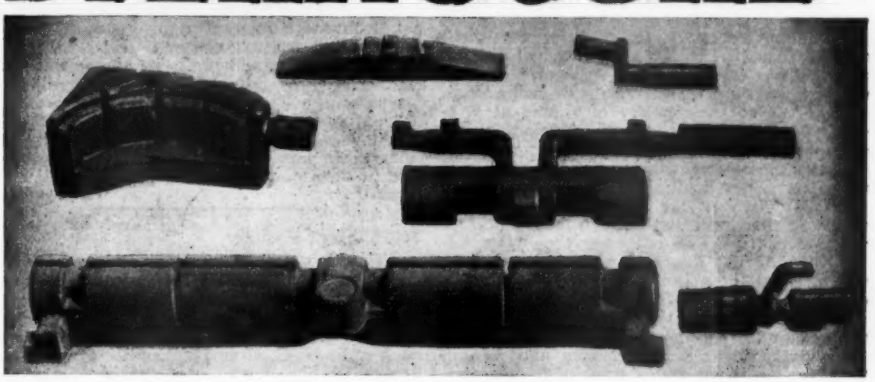
War-time production demands

Every spoiled casting wastes time, wastes metal, wastes fuel, wastes labour and wastes money.

STERNOCORE High-efficiency Core Oils, Creams and Compounds minimise this wastage and effect still further savings by reducing the amount of fettling required.

STERNOCORE

- HIGHER PERMEABILITY.
- QUICKER DRYING.
- LOW GAS EVOLUTION.
- LOWER TRUE COST.
- REDUCED OBJECTIONABLE FUMES.



STERNOL LTD., FINSBURY SQUARE, LONDON, E.C.2

Telephone: Kelvin 3871-2-3-4-5 Also at Bradford & Glasgow. *Telegrams: "Sternoline, Phone, London."*

South African Iron and Steel Industry

ISCOR'S LOWER PROFITS

Manufacturing profits of the South African Iron & Steel Industrial Corporation, Limited, fell to £788,535 in the year ended June 30, 1941, from £1,168,902 in the previous twelve months. For the financial year to June 30, 1939, the manufacturing profit was £1,189,434, and to June 30, 1938, £1,236,122.

Explaining the reasons for the decline in profits at the annual meeting at Pretoria on December 17, Dr. H. J. van der Bijl, chairman of the Corporation, said there was an impression that, because of the war, Iscor was turning out more steel and making larger profits. This was just the reverse of the truth. During the year preceding the war, Iscor works was producing continuously at full output capacity, and the advent of the war did not increase Iscor's output. It merely caused a diversion in the use of its products and, in respect of the numerous special grades of steel manufactured by Iscor for various defence purposes, the production displaced a much larger tonnage of normal commercial grades of steel, and thus actually resulted in an appreciable reduction in their output. While it was therefore true of many industries, and especially manufacturing industries, that the direct and indirect consequences of the war were increased output, increased turnover and increased profit, Iscor was one notable exception.

The decrease of £380,000, or nearly 33⅓ per cent., in manufacturing profit was due to the fact that they had been faced, on the one hand, with very considerable increases in costs of production, due to a variety of causes arising mainly out of the war; and that they had not, on the other hand, increased iron and steel prices to offset the rising costs, said the chairman. An apparent exception to this general rule was made in the case of galvanised sheets. The cost of spelter had more than doubled since the outbreak of the war, and it was found necessary to increase the price of galvanised sheets accordingly. This was not, however, an increase in the price of the steel, but an increase in the price of the zinc coating.

Costs and Production

The increase in the unit costs of their steel products was very considerable, and was due not only to new and increased items of production expenditure, but also to reduction in output. They had to take both of their blast furnaces out of commission for relining, which, in each case, meant the loss of about two months' output. During the year under review, they were operating with one blast furnace for 102 days out of the 365. It would normally be unusual for both furnaces to be relined during one year, but instead of carrying out their programme for staggering the furnace relinings, they decided, after the outbreak of war and in view of the shortage of iron and steel in South Africa, to operate both blast furnaces to the last limits of the life of the refractory linings, and this resulted in the two furnaces having to be relined within eight months of each other. This must, of course, be taken into account when comparing the financial and other results for the year with those of previous years. The fact that they had hitherto refrained from making one or more general increases in steel prices, to offset advancing costs, was due firstly to their policy of aiming at price stability. Their long-range objective was the greatest possible measure of stability in steel prices in the interests of steel consumers and steel producers alike. They had also been influenced by the fact that many of the increases in costs were temporary in character; that through their continued efforts towards improved efficiency they were offsetting some of the increases and that, with the plant extensions now in hand, they could look forward to expansion of their output in stages during the next year or two which would operate in the direction of reducing unit costs and increasing turnover and profits. Secondly, they had seen in South Africa, as elsewhere, evidence of the development of an ascending spiral of costs, prices and wages (including cost-of-living allowances) so characteristic of the beginnings of inflation. He believed that they in South Africa could, if they would, go a long way towards limiting this development. If each individual were to decide (within such limits as each could afford) to absorb the first 5 per cent. or 10 per cent. or 20 per cent. of the rise in costs, without in turn asking a higher price for his products or a higher wage for his services, they would, he was confident, break the vicious circle and call a halt, at least temporarily, to the inflationary movement. It was as a contribution to that objective that Iscor had absorbed such a large increase in costs without increasing steel prices. There were, of course, limits in every case, and he admitted that they had reached the limit of what Iscor could be reasonably expected to bear.

In connection with the installation of converter plant to operate in conjunction with their open-hearth furnaces, under the "Duplex" process (and the coincident erection of a second battery of coke ovens), which would give an increased output at the rate of about 100,000 ingot tons per annum, Dr. van der Bijl said that this plant was ordered just prior to the war, and would, under normal circumstances, have been in full production early in the present year. There had, unfortunately, been protracted delays in the completion and shipment from overseas of the plant, and although portions were now in production, they would not obtain the full benefit of these extensions for another few months—or at least twelve months later than would normally have been the case.

Steel Billet Imports

The local steel industry had, in order to assist in meeting steel requirements during the crisis, arranged to supplement local steel production by importing steel billets for re-rolling and re-processing in South Africa, there being rolling-mill capacity available in excess of the steel-ingot production. The importation, distribution and financing of these billets was handled by a departmental body formed by the several local steel companies and known as the Steel Billet Pool. Due, *inter alia*, to the delay in completing their "Duplex" plant, surplus rolling-mill capacity had been available to a greater extent and over a longer period than was originally contemplated, and, in consequence, the operations of the billet pool assumed very large proportions. Since its formation a little over twelve months before, the pool had handled over 100,000 tons of billets of a delivered value exceeding £1,500,000. The imported billets cost substantially more than locally-made billets, and the difference was recovered by the pool by means of a temporary surcharge applicable to a wide range of finished products by the local steel industry. There remained, however, a saving to steel users as compared with the alternative of importing finished steel products from overseas. The individual steel companies collected the surcharge and paid it over, in full, to the pool, which was itself a non-profit-making body.

In order to assist in affording relief in connection with the acute steel position likely to continue in the Union during the war, the directors had decided to proceed immediately with certain further plant extensions which, working in conjunction with their existing plant, would increase their total production and their range of products within a comparatively short time. Certain orders for plant had been placed overseas which, if delivered according to programme, would mean an appreciable further increase in their output in 1943. The full scheme for a new and self-contained steelworks in the neighbourhood of Vereeniging would, of course, take much longer to complete, even in normal circumstances, and it was difficult at the present juncture to determine when it might be practicable to proceed.

The Umgeni Foundry

"The South African Engineer and Foundryman" in its December issue contains a short description of this old-established Durban, Natal, concern. Founded in 1880 by Mr. Michelson, it is now owned by Mr. V. K. Price, and is managed by Mr. F. H. C. Oram, a member of the London Branch of the Institute of British Foundrymen. It has well over 100 on its staff, of which 70 are natives. Metal is brought down in three 3½ tons per hr. cupolas, supplemented by a cupolette. Much of the work is of a jobbing character, but a speciality is made of sugar-refinery machinery castings. The Meehanite process has been in operation for some years at this foundry.

Reorganised Training of Welders

MINISTRY OF LABOUR COURSES

The increase in the use of the welding processes in munitions production requires the training of additional welding labour. To assist in meeting the need, the Ministry of Labour Training Centres, the largest organised training authority under centralised control, have completely re-organised their welding training in accordance with recommendations put forward by the Institute of Welding. The training under the revised scheme gives a carefully graded course of instruction founded on basic principles, and arranged to provide the welder with a sound understanding of the operations and technique which he is required to master. The Centres have a training capacity of 700 places, of which 320 are for arc and 380 for gas welding. Operating on a three-shift system, it is therefore possible to train 5,000 welders per annum for all requirements.

The Training Centres are prepared to provide trainees or to give training in the following groups:—(*a*) Single purpose welders (downhand only) for mass production welding operations; (*b*) specially trained welders for specific welding operations; (*c*) men or women provided by the welding employer for training in specific welding operations; (*d*) trainees who have received the complete syllabus of training and who have passed the full series of proficiency tests for general work.

Under group (*a*) arc welders receive basic training in mild steel welding of all types of joints (downhand only) in plate thicknesses from $\frac{1}{8}$ to 1 in. Gas welders receive similar training in plate thicknesses from 20 S.W.G. to $\frac{1}{4}$ in., and this range is also covered by carbon or metallic arc processes for arc welders. In group (*b*) the training may cover welding in all positions, not only in mild steel, but in high-tensile, stainless, and other commercial alloy steels, together with the welding of non-ferrous sheet and plate, *i.e.*, aluminium, copper, monel, brass and other alloys in either the arc or gas processes. In addition, the welding of thick and thin walled tubing is taught. Group (*d*) covers those trainees who, by possessing special aptitude to benefit by a longer course of training, have been successfully passed through graded courses to reach the required state of proficiency in the given section.

In order that the fullest and most efficient use may be made of the training facilities provided, the Ministry of Labour is anxious to have the close co-operation of employers of welding labour. It is requested that employers likely to require welders from Government Training Centres will notify their possible requirements on the appropriate form to the Regional Office of the Ministry of Labour, in order that the probable demand, both as to number and type of training required, may be estimated. The managers of the Centres will welcome discussions with individual employers on their requirements.

The period of training under war-time conditions cannot provide the background of experience required for production work in industrial workshops, and it is important that employers should collaborate by providing conditions which will favour a rapid assimilation of this background. Sympathetic guidance during a preliminary period is necessary; but provided the limitations of the newly trained welders are acknowledged, the trainees should prove quite satisfactory for the majority of welding operations.

As men of military age are only accepted for training if they are of low medical category, and are not likely to be required for the Armed Forces, it will be increasingly necessary to employ women on a wide range of welding operations. Many women trainees prove good welders on light materials, and women are now welding heavy work where suitable handling appliances can be provided. Consideration should be given to the organisation of welding work to enable women welders to be used as widely as possible in order to release men welders for work requiring longer experience.

REGULATIONS HAVE BEEN made for the control of iron and steel in South Africa. They empower the Minister of Commerce and Industries to appoint a controller who may lay down conditions for "the acquisition, disposal or use of any controlled material or manufacture of any article which consists of or contains any controlled material."

W

Pig for Victory

We have amended the popular slogan because most of the qualities required for victory are inherent in Warner Pig Iron.

Toughness — Resistance to wear and tear—Strength—Uniformity — Reliability—and Economy, to mention but a few.

Admittedly, we can think of no spiritual virtues which Warner Pig Iron can contribute to the winning of this war — although our artist obviously regards it as pig-headed and we can at least hope that this will confirm the worst suspicions of the enemy regarding everything British.

Warner's

Special Pig Irons

WARNER AND CO. LTD., CARGO FLEET, MIDDLESBROUGH

W

The Week's News in Brief

Trade Talk

THE FIRST WESTERN HEMISPHERE FOUNDRY CONGRESS will be held jointly with the 46th Annual Convention of the American Foundrymen's Association in Cleveland, April 18 to 24.

THE 10s. ORDINARY SHARES of Lake & Elliott, Limited, steelfounders, were introduced to the Stock Exchange last Wednesday week, and at the close of business they were quoted at 20s. 6d.-21s.

THE AMERICAN ZINC COMPANY of Illinois is to double the electrolytic unit at Monsanto, and instal other plant which will increase the combined capacity of the two plants by 2,000 tons slab zinc per month.

THE SECRETARY OF STATE FOR SCOTLAND has invited local authorities and organisations to send representatives to a conference in Edinburgh to discuss the question of industrial development in Scotland after the war.

THE MINISTER OF WORKS has made an Order (S.R. & O., 1942, No. 57) under which persons or undertakings owning certain items of contractors' plant are required, when requested, to furnish information about such plant. Items affected by the Order include excavators with their equipment, mobile cranes, tractors, and portable compressors.

IN THE HOUSE OF COMMONS, the Minister of Labour has been asked if his attention had been drawn to the position in a certain area where industrial plants were in danger of having to close down because of a lack of moulding sand, the quarries being unable to secure the necessary labour. Mr. Bevin replied that he would look into the matter.

IN SETTLEMENT OF A CLAIM by the Welsh founders and engineers for an increase in their wage rates an offer by the employers has been accepted as follows:—Fully qualified craftsmen: Penny per hr. increase to 2s. 1d. per hr. for a 47-hr. week; all other grades, increase of a halfpenny per hr.; bonus for workers on continuous piecework increased by 2s. to 12s. 6d. per week.

IN VIEW OF THE new situation in the tin industry and, in particular, the cessation of the world market, A Strauss & Company, Limited, 37-39, Lime Street, London, E.C.3, feel that they will no longer be rendering any worthwhile service by the regular publication of their monthly tin review, and publication is suspended with the issue dated January 6 last. The review has been published for many years past, and we feel that many of our readers must have found it useful, and will wish that it will be possible for publication to be resumed in the not too far distant future.

UNDER A BOARD OF TRADE ORDER, which comes into force on February 10, licences will in future be required to export the following classes of goods to all destinations:—Machinery belt fasteners, certain additional classes of machinery; strapping, baling, nailing and stapling machines; anvils; and tools, hand and bench, and parts thereof, not elsewhere specified in the Schedule of Controlled Goods. The control in respect of machine tool parts and accessories (including jigs and fixtures) is extended to cover small tools for machine tools. Copies of the Order (S.R. & O., 1942, No. 68) are obtainable, price 1d., from H.M. Stationery Office.

STATING THAT THE COUNTRY was still a long way from being organised for total war, Mr. David Brown, at the annual meeting of Huddersfield Chamber of Commerce, added: "One of the main difficulties is that a large number of companies are to-day in the position of having several different Ministries pulling at them in different directions, and each with little regard for anything except its own immediate problems. These things I feel are detracting from the efficiency of the engineering industry." Mr. Brown said that the unskilled labour, particularly that of females, in the engineering and other war industries, was magnificent; and he complimented skilled workers on the way in which they were co-operating in training the newcomer.

THE FORMATION OF A SUB-COMMITTEE to overhaul war production is advised by the T.U.C., and is under discussion by the Production Executive. A statement issued last week said: "At a meeting of the Central Joint Advisory Committee to the Production Executive of the Cabinet, the trade union side gave notice of a motion to appoint a small joint sub-committee to examine the present machinery of production in order to see whether it could not be materially improved. The general council of the T.U.C. is very perturbed at the number of reports of slackness it is receiving from trade unions and other quarters. It is felt there is a considerable amount of improvement which can be secured. The resolution is under discussion by the Production Executive."

SIR PATRICK HANNON, M.P., speaking on "Productive Industry and the War" at the annual meeting of the Midland area of the National Union of Manufacturers in Birmingham, commented on "the remarkable industrial vitality of this country" and paid tribute to the quality of managements and the skill and devotion of workpeople. In times like these, when criticism and misunderstanding were rife, he said, there was a tendency to throw blame on managements. When the economic history of to-day came to be written the great contribution of managements to the war effort would be one of the outstanding facts associated with the war. It had been hinted in various quarters that management of industry could be improved by the formation of works committees, and one read that trade unions were making this objective part of their policy. Sir Patrick suggested that before the Government committed itself to divide the directive management of industry between those who were executives and those who represented trade unions very serious thought should be given to the matter.

SPEAKING AT A LUNCHEON organised by the South Wales Institute of Engineers, at Cardiff, the Earl of Plymouth said that in the past attention and the constructive enterprise of engineers in South Wales had been directed into two main channels—coal-mining and ship-repairing—and, although it was perfectly true that Wales was making a great contribution to the war effort through the production of her coal, steel, tinplates, etc., the fact still remained that the bulk of her contribution was provided by plant, and very often buildings, which had been erected since the war began. In addition to that it had been necessary to bring into the area a considerable amount of skilled labour to supervise and train labour. He hoped that at the end of the war the Institute would add to the signal service which it had already rendered to the progress and prosperity of the Principality by seizing the opportunity given by the presence in Wales of these machines to create a new engineering industry on a broader basis than had obtained up till the present. He believed that in that way, and that way alone, was it possible to build up an alternative to the coal, shipping and steel industries.

Obituary

MR. WILLIAM DOWNS NELSON, retired brassfounder, died at Edinburgh on January 23.

MR. JAMES E. WHITEHEAD, of Whitehead & Poole, Limited, engineers, Radcliffe, Lancs, died recently.

LORD ILLINGWORTH, who died on January 23, was chairman of the United States Metallic Packing Company, Limited.

MR. JOSEPH M. SELLERS, a partner in the firm of W. Sellers & Sons, machine makers, Airedale Works, Keighley, died recently, aged 86.

MR. HARRY LENTON RUST died recently, at his home in Sheffield, aged 67. He had been secretary of Kayser, Ellison & Company, Limited, steelmakers, for 40 years.

MR. FREDERICK SIDES, who was employed by Thos. W. Ward, Limited, Sheffield, for more than 38 years as representative of the scrap iron and steel department, has died at Buxton.

MR. ANDREW STONEHOUSE, who died recently at Middlesbrough, in his 83rd year, was for 29 years works engineer at the Newport Ironworks. He was the oldest surviving member of the Middlesbrough and District Association of Foreman Engineers and Chief Draughtsmen, of which he was president in 1901 and again in 1927.

MAJOR HERBERT ENSOR, who was in charge of the L.N.E.R. locomotive department at West Hartlepool until his retirement nine years ago, died recently. Major Ensor was an engineering pupil at the Darlington North Road locomotive works and later was employed by the L.N.E.R. at Stockton, afterwards being transferred to West Hartlepool locomotive works.

MR. GEORGE SCOTT MACLELLAN, a former director of P. & W. MacLellan, Limited, died in Glasgow on January 23. Mr. MacLellan, who was 81, retired from active business about ten years ago. Well known in the iron and steel trade, he was the oldest member of the pig-iron "ring." The eldest son of the late Mr. Walter MacLellan, he was educated at Glasgow Academy, and was associated all his business life with the engineering firm, latterly holding the office of vice-chairman.

MR. CHARLES HEATON BARWELL, chairman of Charles Clifford & Son, Limited, brass and copper tube manufacturers and metal rollers, of Birmingham, has died at the age of 81. He became a director of the company in 1899, in succession to his father, the late Mr. William Barwell, and was made chairman in 1912, but resigned later owing to pressure of other interests and was succeeded by Mr. Thomas Ratcliff. When Mr. Ratcliff died in 1927 Mr. Barwell was again appointed chairman, and retained that position up to the time of his death.

Personal

SIR PAUL AND LADY BOOTH celebrated the 25th anniversary of their wedding last Saturday.

MR. G. H. SMEETON, of Cheadle Hulme, Cheshire, has joined the board of John A. Smeeton, Limited, engineers, contractors and merchants, 76 Auckland Road, London, S.E.19.

MAJOR W. R. BROWN, D.S.O., sales manager, and Mr. J. A. Hunton, general works manager, of Ashmore, Benson, Pease & Company, Limited, have been appointed directors of the company.

MR. SUMMERS HUNTER, managing director of the North-Eastern Marine Engineering Company, Limited, has been elected a member of the River Wear Commissioners, representing the engine builders, in place of the late Mr. Robert Haswell.

MR. W. MURRAY MORRISON, vice-chairman and managing director of the British Aluminium Company, Limited, has been awarded the Platinum Medal of the Institute of Metals for 1942 in recognition of his outstanding services to the non-ferrous metals industries.

MR. J. ALLEN HOWE has been elected president of the Institution of Mining and Metallurgy for the year 1942-43, and will take office in May. Mr. Howe was appointed to H.M. Geological Survey in 1901, serving for thirty years on the field staff and as curator of the Museum of Practical Geology and from 1922 onwards as assistant director. During his service he took an active part in stimulating the economic side of the Survey's work and he is the author of several works, mainly dealing with building stone, broken stone, and refractory materials. He was a member of international conferences on testing materials, and was for a number of years adviser on stone to H.M. Office of Works. He was a member of the Committee on Coal Conservation and the Imperial Economic Committee. Since 1931, Mr. Howe has practised as a consultant in economic geology.

Will

SMITH, SAMUEL, of Tenbury Wells, managing director of Samuel Smith & Sons, Limited, Beehive Foundry, Smethwick; director of Wilkes, Limited, bolt and nut manufacturers, Darlaston; and associated with the old National Light-Castings Association £6,5

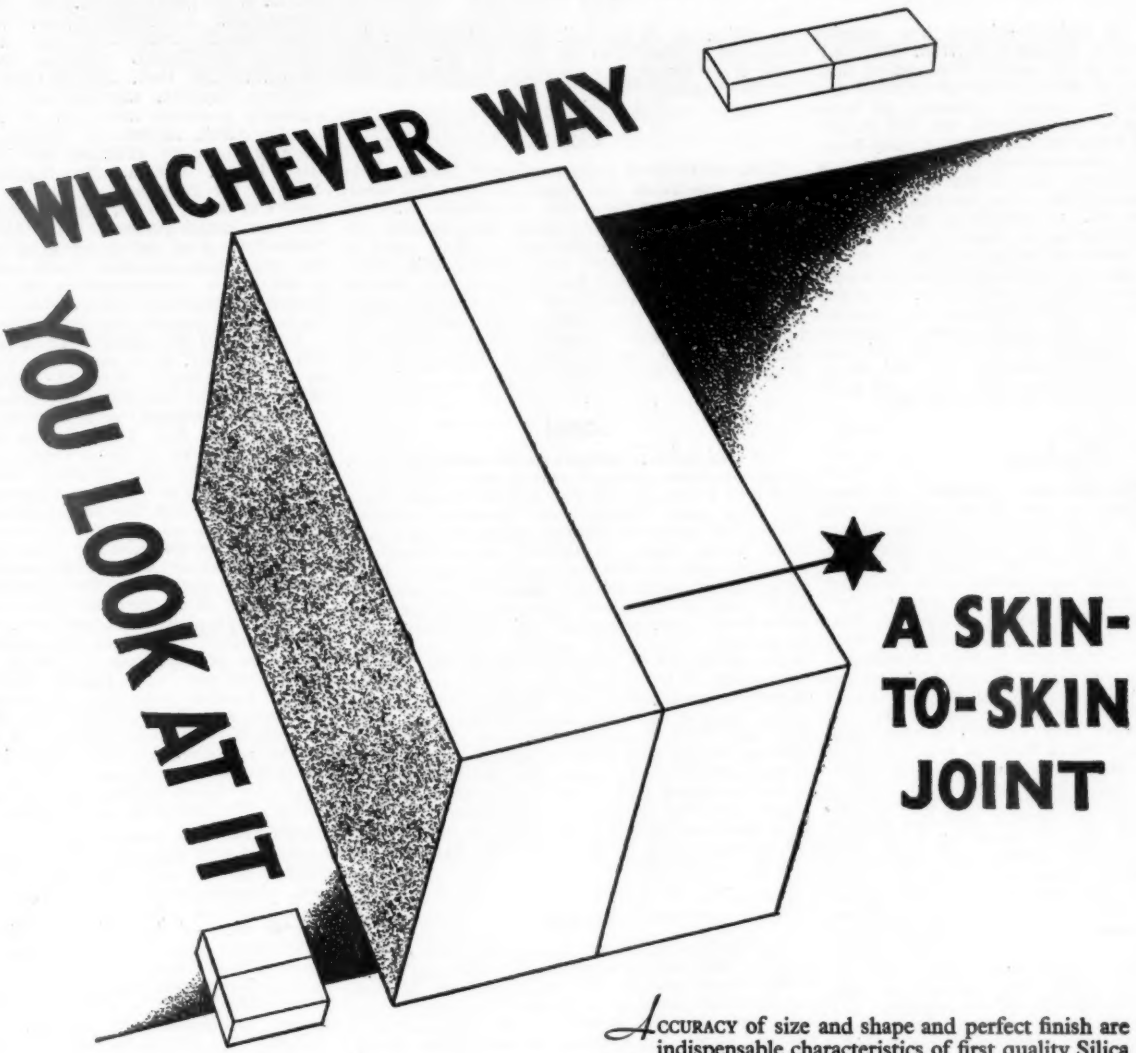
Contracts Open

Caernarvon, February 21—Iron castings during the year ending March 31, 1943, for the Caernarvonshire County Council. The City Surveyor, County Offices, Caernarvon.

Dublin, February 14—Iron castings; cast-iron pipes; pig-lead; steel reinforcement, etc., for 12 months from April 1, for the Town Council. The Housing and Supplies Department, Exchange Buildings, Lord Edward Street, Dublin.

Stourbridge, February 9—Cold-blast furnace slag for 12 months ending March 31, 1943, for the Town Council. Mr. G. N. Maynard, borough surveyor, Council House, Stourbridge.

Godalming, February 9—Supply and laying of 200 yds. of 4-in. dia. spun cast-iron main, for the Corporation. Mr. E. G. Bowyer, water engineer, 35, Bridge Street, Godalming, Surrey. (Fee £2 2s. returnable.)



ACCURACY of size and shape and perfect finish are indispensable characteristics of first quality Silica Bricks for use in all furnace structures — converters, electric, open hearth, and glass furnaces, and so on. A "well-fitting" lining of Silica Bricks, for example, is impossible, unless the refractories used provide real "skin to skin" joints.

G. R. Silica Bricks are recognised and widely accepted as refractories possessing these qualities. In addition, they are uniformly consistent as regards refractoriness-under-load, bulk density, high degree of conversion, and volume stability at melting temperatures.

When you build with G.R. Silica Bricks you build with assurance and confidence.

G.R. Silica Brands include:

LOWOOD. Made in one of the largest and most modernly equipped silica brick works in the world. Careful selection and blending of silica stone, mechanical grading and powerful presses are all factors in the manufacture of bricks able to withstand the severe conditions of modern furnace practice.

ALLEN. Like Lowood, these are widely used in converters, open hearth and electric furnaces, and glass tanks. Modern methods of manufacture ensure the production of uniformly well-fired bricks of low porosity and perfect finish.

GENERAL REFRACTORIES LTD.

HEAD OFFICE: GENEFAX HOUSE, SHEFFIELD, 10. TELEPHONE 31113 (6 LINES)

G.P.36

FIREBRICKS: *Glenboig Special, Glenboig Special Crown, Glenboig, Glenboig Crown, Castlecary, Dykehead, Gem White Carr, Stour, Hycone, Alumantine, Hysilyn, Adamantine, Llangennech.*
BASIC BRICKS: *Spinella, Saxpyre, Supermag, Diazite, Dolomax.*
ACID-PROOF REFRACTORIES: *Obsidianite, Losol.*

INSULATION: *Amberlite* Bricks, Cement and Concrete.
SILICA BRICKS: *Lowood, Meltham, Allen, Quartex,*
CEMENTS: *Sintex, Durax, Pyrolyte.* PLASTICS: *Durax, Rotaline. Plastic K-N., Glendoline, Ground Ganister, Steel Moulders' Compositions.* SILLIMANITE: Tank Blocks, Bricks and Cements. SANDS: Moulding, Brick Facing, Silica, Glass.

Raw Material Markets

Consumption of high-phosphorus iron remains somewhat restricted, as demands from the light-castings trade, the chief user of this type of iron, are in proportion to the curtailed activities of that branch of industry. Ample quantities of high-phosphorus material are available, the ores needed for manufacture being located in the United Kingdom, whereas the ores required for the production of better types of iron, such as low- and medium-phosphorus grades, have to be imported. Heavy engineering firms, etc., are absorbing very substantial tonnages of these irons, together with hematite, and their needs are being satisfied promptly in the main, as they are mostly employed on urgent contracts directly associated with the war effort. Hematite supplies are still anything but plentiful and allocations are only made when alternative grades will not adequately fill the breach, and then only if the consumer is engaged on vital work. Output of basic iron is at a high level, and good deliveries are being made to the steelworks.

Pig-Iron

MIDDLESBROUGH—The position of ironmakers in this district is very strong, and full outputs are disposed of as available. In view of the insatiable needs of the steel industry, ironworks are having to concentrate their attention on the production of steelmaking qualities, and Cleveland foundries have to seek elsewhere for their requirements. The bulk of the supply of foundry iron is acquired from the Midlands, producers there being able to deliver sufficient to meet the reduced needs of the light foundries. Heavy founders are universally busy, but they, too, can get all the iron they want. Only really essential users of hematite are obtaining supplies, other consumers being compelled to utilise alternative types of iron, which in many cases meet their requirements satisfactorily.

LANCASHIRE—Derbyshire and Staffordshire No. 3 foundry irons are only in moderate request from buyers in this area, this being due to the fact that conditions among light-castings works and most of the jobbing foundries are still far from happy. They are not called upon to cater extensively for either home or export buyers, and the volume of Government work is quite insufficient to bring their order-books up to peacetime levels. Activity in the heavy engineering section, however, tends to expand, as works are required to cope with a considerable amount of Government and other special business. Consequently, the demand for pig-iron from these concerns is quite brisk. Hematite is not arriving at all satisfactorily, and the use of this grade is severely curtailed, while forwardings of Scottish foundry irons are not quite so regular as they have been in the past. Fortunately, supplies from the Midlands are maintained.

MIDLANDS—Apart from high-phosphorus iron, of which considerable stocks are on hand, business in iron is largely of a hand-to-mouth character, purchasers being granted licences to cover only their immediate needs. A fair tonnage of high-phosphorus iron is being taken up by heavy engineers as a substitute for better qualities, which are less easily procured, but, in the aggregate, demand for this particular grade is not active, the light-castings industry, which can usually be relied upon to absorb appreciable quantities, being poorly placed for work. Heavy engineers, generally, are as busy as their capacity will permit, and most of their orders are of an urgent nature. Low- and medium-phosphorus irons, refined iron and steel scrap, together with a certain amount of high-phosphorus iron, are being called for, while in a few cases hematite is being handed out, but only if it is impracticable to use alternative descriptions, as supplies of hematite have to be carefully conserved for future requirements.

SCOTLAND—Deliveries of low-phosphorus iron are still not up to expectations, but consumers have been able to avoid loss of output, many of them having stocks on hand, although in no case are these reserves at all extensive. It is greatly to be hoped that there will shortly be a marked improvement in despatches of low-phosphorus material, as users are operating at peak levels. In the case of light-castings foundries, only a few are in possession of full order-books, the others mostly working a short week. Local steelworks are hard pressed to satisfy all the orders on their books, and are taking up all the basic iron and hematite they can secure. Deliveries of hematite are especially difficult to obtain, but adequate tonnages of basic are forthcoming.

Coke

Coke ovens have large supplies of foundry coke in their possession, but during the past few weeks transport has not been easy to arrange, with the result that consumers relying upon weekly deliveries have been handicapped. Most users of large tonnages, however, have stocked fully for a long time past, so that they have not been affected by the prevailing conditions. The Control quotation for Durham best foundry coke, delivered Birmingham and Black Country stations, remains at 62s. 9d. per ton, and all forward business in coke is subject to a rise-and-fall clause.

Steel

The steel industry appears to be somewhat busier. Certain sections have, of course, been fully occupied over a long period, but in other quarters there has been some falling away in recent months. Makers of structural sections, joists, etc., are now being called upon to deliver larger quantities, although they are not yet unduly pressed. Plate mills cannot easily accommodate further business, while most of the sheet mills are carrying good order-books, both galvanised and black sheets being in demand. Cold-rolled strip is used extensively in the production of munitions, etc., so that makers are assured of active conditions over a long period. Hot-strip manufacturers, too, are busy, while bright-drawn steel is in strong demand. It would seem that there will be developments in the hematite situation in the near future; supplies for the steelworks have not been satisfactory for months past, and it is hoped that it will be possible to raise bigger quantities of ore in this country. Special alloy steels continue to be absorbed in ever-increasing tonnages, and outputs are being increased as speedily as possible.

Scrap

The Minister of Works has been given powers under a new defence regulation to make an order calling upon owners and occupiers of specified categories of premises to disclose any metal suitable for scrap which is on those premises at a specified date. An Order is being drafted which will provide for compulsory returns to be made of all disused machinery, plant and other types of unwanted metal. It is understood that the response of the public to the appeal by Mr. George Hicks on January 21 for assistance to enable the Ministry of Works to locate iron and steel scrap for munitions has been exceptionally gratifying, reports steadily pouring in of hitherto untapped resources.

Metals

COPPER—Mr. Churchill, in his speech to the House of Commons last week, said that production of field gun ammunition had doubled during the last six months. This is but one indication of many of the increasing use of copper in the manufacture of weapons of war, and it is a source of considerable satisfaction that these works are getting adequate deliveries of the red metal. Libya and the Far East must be accounting for the use of vast quantities of munitions, while we are also pledged to ship supplies to the Soviet Union. Thus, it is not surprising that releases of copper for non-essential purposes are of very small proportions.

TIN—Official buying and selling prices for tin have still to be announced and, meanwhile, the Ministry of Supply is quoting a provisional selling price of £275 per ton, delivered consumers' works, plus extras, if any.

The tin supply position of the Allies is viewed with sober optimism in "Tin," the organ of the Tin Producers' Association, and it is suggested that, in spite of the fact that the Japanese have overrun the richest tin-bearing area in the world, the supply situation is less serious than contemplated in some quarters. Stocks in the United States are so large that they will be sufficient to supplement current imports for some time ahead without involving any decrease in war supplies. Malaya, the world's largest producer of tin, was responsible for some 32.5 per cent. of the total output in the year ended October, 1941, when world production, at 259,887 tons, was a record. This figure compares with a world production of 236,600 tons in the year ended December 31, 1940, and 183,800 tons in 1939. Malayan supplies, together with those of other signatory countries which are no longer available to the Allies, amount to 102,950 tons. The remaining signatory countries are the Netherlands East Indies, Bolivia, the Belgian Congo and Nigeria, the combined output of which, 129,340 tons, was nearly 50 per cent. of the world total in the year ended October, 1941. Of this total, the Netherlands East Indies produced 53,890 tons and the other three countries 75,450 tons. Dutch tin production is concentrated on the three islands of Banka, Billiton and Sinkep, which are well within the scope of possible Japanese aggression.

A survey of the supply position suggests that the Allies can rely, at a most conservative estimate, on annual deliveries from the signatory countries of, say, 130,000 tons if the Netherlands East Indies' exports are included, or 76,000 tons if the Dutch supply should fail. Consumption in manufacture in the United States, Great Britain and the Soviet Union is at the rate of about 140,000 tons per annum, says "Tin." The position would be grave if it were not for the very satisfactory level of stocks.

Considerable difficulty has been encountered by tin companies in establishing contact with their general managers since the Japanese invasion of Malaya, but seven companies have announced that the use of all plant and machinery at the properties was effectively denied to the enemy before the evacuation of the States of Perak, Selangor and Negri Sembilan. No further dividend payments will be possible until after properties, plant and machinery have been repaired and operations again resumed, but the cash resources of each company will be conserved in every possible way. The companies concerned are Gopeng Consolidated, Rambutan, Tekka-Taiping, Tekka, Pengkalen, Kent (F.M.S.) Tin Dredging and Seremban.

SPELTER—The importance of spelter to the production of war materials is very great, and at the moment priority consumers are securing all they need. Applications for fresh supplies are carefully scrutinised, and control is likely to tighten still more in view of the serious position in the Far East fighting zone. Zinc production in South Australia, New South Wales and Tasmania is playing a major part in meeting the zinc requirements of the Allies, and it is highly desirable that interruptions in shipments be avoided.

LEAD—The war in the East must inevitably have some effect on lead supplies, also, in view of the possible threat to shipments from the Australian mines and the menacing Burmese situation. So far, however, consumers in this country are amply supplied. American users of the metal rely to a considerable extent on Empire production, so that it is vital that deliveries be maintained as far as possible. In the past lead has been used in the United States as a substitute for other materials, but now there is a shortage of lead.

MAGNETIC SEPARATORS
"RAPID-BIAFLUX" Patent
PULLEY & DRUMS
The Popular
"OVERBAND"
FOR FOUNDRY SANDS
LISTED IN 5 SIZES
LIFTING MAGNETS
FOR PIG IRON & SCRAP
CLUTCHES & CHUCKS
THE RAPID MAGNETTING MACHINE Co., Ltd.
Magnet Works, Lombard St., Birmingham, 12
'Phone: Victoria 1137-8 'Grams: "Berlage, Birmingham 12."